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Factors Governing the Strength of Gear Teeth

By DOUGLAS T. HAMILTON

The first article—Materials and treatment for safe stress—Selecting a diametral pitch—How form and shape of gear tooth affect its strength

ALTHOUGH much has been written about the strength of gear teeth, the various conditions that govern or control the strength of the teeth have not received the attention that the subject deserves. It is a self-evident fact that the conditions under which a gear is to operate as well as all of the underlying factors must be known before the effective strength of the teeth can be determined.

Among some of the principal governing factors, which might be mentioned are:

(1) Material;
(2) Diametral pitch;
(3) Form and shape of tooth, which would embrace the pressure angle, length of addendum and inclination of the tooth bearing with relation to the axis of gear;
(4) Number of teeth and tooth ratio of gears in mesh;
(5) Velocity;
(6) Accuracy of the gear and method of mounting it;
(7) Reversal of motion;
(8) Backlash.

In regard to the first factor, material, some materials will resist wear and withstand greater bending stresses than others. Consequently, the first point to consider is the material from which the gear is to be made, and the treatment it will receive during fabrication. In taking the question of material into consideration, the method generally followed is to determine a safe stress for the material used. This safe stress is considered as two-thirds of the ultimate strength for cast iron and two-thirds of the elastic limit for steel. Rawhide, vulcanized fiber and impregnated cotton or duck are used interchangeably with cast iron; that is to say, they have approximately the same strength, and can be used to replace cast-iron gears, when quiet operation is desirable.

The strength of a gear tooth when the gear is made from alloy steel, is largely governed by the method of fabrication and the heat treatment the material receives. As an example, a nickel-steel gear made from stock having an analysis in accordance with S.A.E. Specification No. 2,320, has an elastic limit varying all the way from 48,000 to 110,000 lb. per square inch, depending upon the heat treatment it receives and the medium in which it is quenched. The higher the drawing temperature, the lower the elastic limit. It is essential to have all of the various factors under control if the best results are to be obtained from the use of high-grade alloy steel. While a high elastic limit or yield point is a necessary requirement in any steel which is to be used for gears, a high compressive strength or wear-resisting properties are of equal and sometimes of greater importance. This fact is especially true when the gears are to operate at high speeds and under heavy tooth pressures.

Cast iron, as a material for gears, is limited in its application to gears that are required to carry only comparatively small power loads at low speeds. Usually 8,000 to 10,000 lb. per square inch, is the maximum safe stress permissible for gears at rest. The safe working stress, of course, is governed by the maximum speed at which the gears are to operate. Cast iron is an unreliable material for high-grade gears, because of the possibility of failure due to casting defects.

The Use of Bronze Gears

Bronze and other non-ferrous metals of a similar nature are used when the element of friction is an important factor. For worm drives, bronze and hardened steel make a good combination, especially if the worm is ground after hardening. The strength of a bronze gear is governed largely by the character of the alloys and their percentages used in its composition. Aluminum bronze is especially tough and strong, and has an elastic limit of 20,000 lb. per square inch. It is also capable of resisting wear to a remarkable degree. Naval bronze is another satisfactory alloy for worm gears and has a compressive strength of 170,000 lb. per square inch. In Table I the elastic limit or yield point of various non-ferrous alloys used for gears is given. The safe working stress for a gear tooth at rest is equal to two-thirds of the yield point or elastic limit.

The use of rawhide, fiber and impregnated fabrics is recommended for gears when silent operation is desirable. These various materials are especially suited for use in connection with the manufacture of motor-drive

TABLE I—PHYSICAL PROPERTIES OF MATERIALS USED IN GEAR MANUFACTURE

Material	Physical Properties 1,000 Lb. per Sq. In.	Remarks	Authority
Nickel steel, S.A.E. No. 2,315	40 to 80*	Heat treatment, S.A.E. "H" casehardening stock	S.A.E.
Nickel steel, S.A.E. No. 2,320	48 to 100*	Heat treatment, S.A.E. "H" oil hardening	S.A.E.
Nickel-chromium, S.A.E. No. 3,250	98 to 200*	Heat treatment, S.A.E. "Q" oil hardening	S.A.E.
Nickel-chromium, S.A.E. No. 3,450	168 to 175*	Heat treatment S.A.E. "R" oil hardening	S.A.E.
Nickel-chromium, S.A.E. No. 3,340	98 to 200*	Heat treatment, S.A.E. "R" oil hardening	S.A.E.
Chrome-vanadium, S.A.E. No. 6,120	55 to 100*	Heat treatment, S.A.E. "S" case hardening stock	S.A.E.
Chrome-vanadium, S.A.E. No. 6,145	98 to 200*	Heat treatment, S.A.E. "U" oil hardening	S.A.E.
Silico-manganese, S.A.E. No. 9,250	60 to 180*	Heat treatment, S.A.E. "V" oil hardening	S.A.E.
Chrome-molybdenum, "MO"-3	185 to 240*	Oil quenched, 1,475° F.	Climax-Molybdenum Co.
Chrome-molybdenum, "MS"	180 to 210*	Oil quenched, 1,500° to 1,700° F.	Climax-Molybdenum Co.
Chrome-vanadium-molybdenum "LM"	132 to 240*	Normalize, 1,600° F.; water quench, 1,450° F.; draw, 1,125° F.	Climax-Molybdenum Co.
Chrome-vanadium-molybdenum "VM"	70 to 220*	Oil quenched, 1,600° F.	Climax-Molybdenum Co.
Steel castings, S.A.E. No. 1,235	27 to 36‡		S.A.E.
Bronze (gear), S.A.E. No. 65	20*		S.A.E.
Cast aluminum bronze, S.A.E. No. 68	20*		S.A.E.
Bronze forgings, naval	58‡		U. S. Gov. Tests
Malleable iron	27‡		S.A.E.
Cast iron	15‡		S.A.E.
Fiber	7.5†	Parallel to laminations	The Continental Fiber Co.
Condensite Celeron	8 to 10†	Parallel to laminations	Diamond State Fiber Co.
Formica, Grade R	10 to 12†	Parallel to laminations	The Formica Insulation Co.
Textoil	8†	Parallel to laminations, max. working stress, 5,000	General Electric Co.
Fabroil	12†	Parallel to laminations	General Electric Co.
Rawhide	8†	Parallel to laminations, max. working stress, 4,800	Chicago Rawhide Mfg. Co.
Bakelite-Micarta D	10†	Parallel to laminations	Westinghouse Elec. & Mfg. Co.

* Elastic limit, pounds per square inch. ‡ Ultimate strength. † Maximum safe fiber stress.

pinions, and engine timing gears. The physical properties are largely controlled by the character of the materials and the methods of fabrication followed.

Bakelite-Micarta D is a non-metallic material made from heavy duck of uniform weave, which is bonded with bakelite by heating while under enormous pressure. It has the following physical characteristics: Tensile strength parallel to laminations, 10,000 lb. per square inch; compressive strength, parallel to laminations, 17,000 lb. per square inch; traverse strength, maximum fiber stress, both parallel and perpendicular to laminations, 17,000 lb. per square inch; coefficient of expansion per inch per degree C., 0.00002 in. in a direction parallel to the laminations and 0.000085 in. perpendicular to them; specific gravity, 1.4; weight per cubic inch, 0.05 lb.; shrinkage, practically zero up to a temperature of 100 deg. C.; oil absorption, none; water absorption, very slight. Under ordinary conditions it is not recommended that Bakelite-Micarta D gears should be designed to operate at fiber stresses higher than 5,000 lb. per square inch. The life of the gear is shortened by fiber stresses higher than this stress.

Formica Grade R is a laminated product made from cotton duck thoroughly impregnated with Redmanol Resin, which is transformed by heat and pressure into a wear resisting material. It has the following physical characteristics: Tensile strength parallel to laminations, 10,000 to 12,000 lb. per square inch; compressive strength, 24,500 lb. per square inch parallel to the laminations and 47,000 lb. per square inch perpendicular to them; modulus of elasticity, 320,000 lb. per square inch; Brinell hardness, 34.4; Scleroscope, 65; specific gravity, 1.38; moisture absorption, practically none; oil absorption, practically none; coefficient of linear expansion, 0.00002 in. per degree up to 150 deg. Fahrenheit.

Characteristics of Condensite Celeron

Condensite Celeron, Grade F is a vulcanized fiber impregnated with condensite (phenol and formaldehyde) and then hardened. When so treated it has the following physical characteristics: Tensile strength, 8,000 to 10,000 lb. per square inch parallel to laminations; compressive strength, 40,000 lb. per square inch parallel to the laminations and 25,000 lb. per square inch perpendicular to them; the traverse strength is about 23,000 lb. per square inch parallel to the laminations and 25,000 lb. per square inch perpendicular to them; modulus of elasticity, 1,550,000 lb. per square inch; specific gravity, 1.3 to 1.4; Brinell hardness, 45 on natural and 36.4 on sawed surface; coefficient of expansion, 0.000017 in. per deg. F.; maximum fiber stress on keyway, 3,000 lb. per square inch.

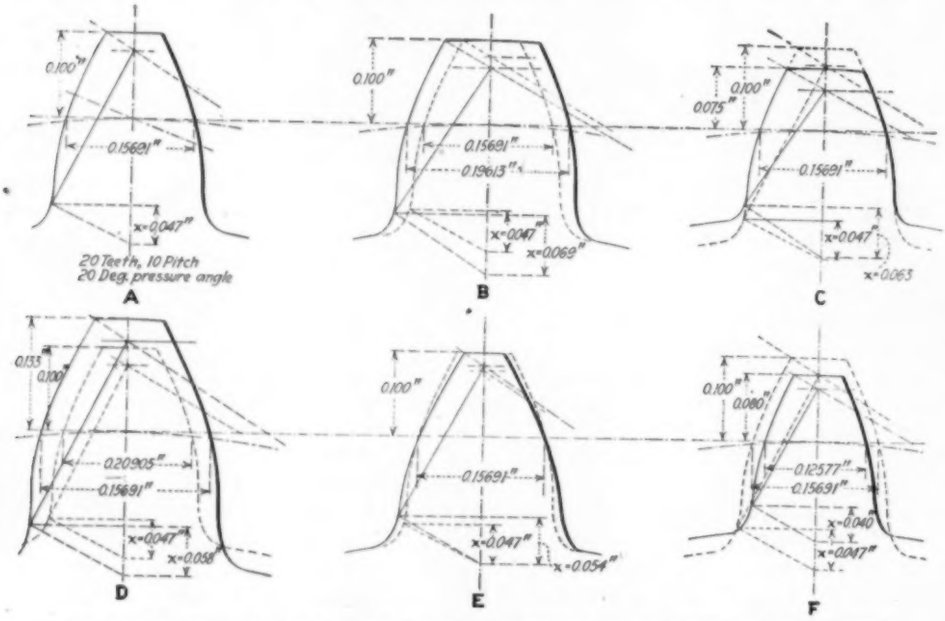


FIG. 1—EFFECT OF VARIATION IN TOOTH SHAPE AND PITCH ON STRENGTH OF TOOTH

Some of these non-metallic materials when used for gears require the addition of side plates or shrouds, whereas others can be used without them. In no case, however, should the steel shrouds come in contact with the mating gear, as by so doing, one of the chief advantages in using the non-metallic material, that is, the quietness of action, would be defeated. Pitch line

speeds up to as high as 3,000 to 4,000 surface ft. per minute have been used with non-metallic gears, but, as a general rule, the manufacturers recommend speeds not exceeding 2,000 ft. per minute.

The pitch of a gear tooth is the next point to consider, and in this connection it should be observed that the conditions of operation and the power to be transmitted govern the diametral pitch that should be selected. The two main conditions that must be considered in the selection of the diametral pitch are:

(1) Pitch and face width of tooth necessary to resist wear. This requirement is important when gears are to carry a maximum load most of the time.

(2) The tooth must be of such proportions as to successfully resist fracture at full load. This requirement is important when the load is not constant, and the gears are to transmit the full load only part of the time.

In some cases, the gears must be made strong enough to resist fracture and at the same time proportioned to resist wear. There is no definite division between these two cases. The question of durability is of just as much importance as the question of strength, but there is no way of calculating durability. It can be determined only by careful tests.

Further, low bending stresses are no safeguard against excessive wear. Quite frequently a few gears of a set will wear out, while others stand up well, even though all were calculated to operate at the same bending stresses. It is generally believed that a coarse pitch does not help to resist the breaking down of the tooth surface. It is a question, rather, of choosing the proper material. The diameter and face width of the gear combined determined the area of contact. Summarizing these deductions, we can assume that

(1) Low bending stresses are no safeguard against excessive wear.
(2) A coarse pitch does not prevent the breaking down of the tooth surface.
(3) The diameter and face width combined determine the area of tooth contact.
(4) Shortening the addendum increases the strength, but not the durability, with the assumption that there is no tooth interference present.
(5) The diametral pitch of the tooth should only be sufficient to resist fracture. Durability is obtained by increasing the diameter and face width, independent of material and treatment.

Some of the conditions summarized here have not been considered up to this point, but will be fully dealt with later.

Aside from the question of material, the form and shape of the gear tooth more than any other factor govern the tooth strength. It is generally known that an increase in the pressure angle increases the strength of the tooth, because such an increase thickens or widens the tooth at its base. The relation of the other tooth elements to the pressure angle, however, has an important bearing on this condition. The following deductions will reveal some interesting facts in this connection. For an example, let us assume that we have a set of gears which are to operate at a fixed center distance; that is, it is impossible to change the center distance or tooth ratio. Which of the following tooth elements most affects the strength of the teeth on the gears in question?

(1) Increase in the tooth thickness.
(2) Decrease in the addendum.
(3) Increase in the face width.
(4) Increase in the diametral pitch.
(5) Increase in the pressure angle.
(6) Increase in the number of teeth.

Take as an example two gears having 20 and 40 teeth, respectively, of 10 pitch, 20-deg. pressure angle, full-length tooth and an addendum 0.100 in. long. The stipulation is that the same center distance of 3 in. must be retained. As the pinion tooth is unquestionably the weaker, we will calculate its strength. This tooth according to the Lewis formula has a strength value

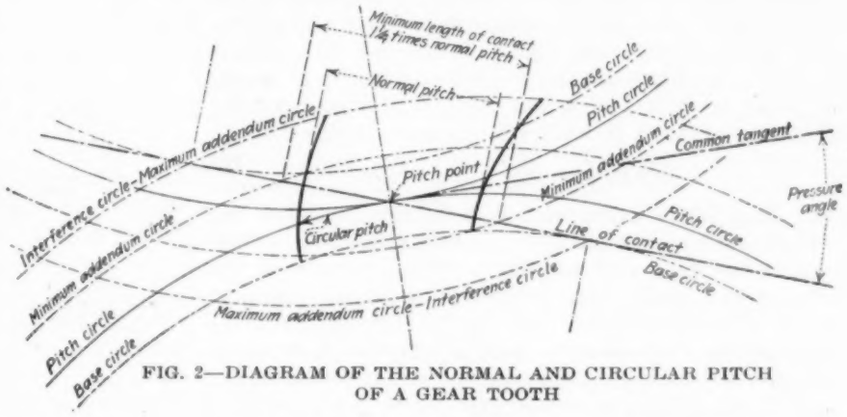


FIG. 2—DIAGRAM OF THE NORMAL AND CIRCULAR PITCH OF A GEAR TOOTH

for x of 0.047, as shown in Fig. 1. In all cases we will increase the tooth element 25 per cent and make the other elements in accordance with or proportional to the tooth element.

(1) *Increase in the tooth thickness.* A careful laying out of a gear tooth will show that an increase in the chordal tooth thickness affects the strength of the tooth to a greater degree than does the changing of the other elements. This feature is of particular advantage when a pinion having a small number of teeth is to operate with a gear having a greater number of teeth. As will be explained in full detail later, this possibility is also taken advantage of quite frequently where balanced strength in gear and pinion is highly desirable.

In Fig. 1, drawing *B* shows a standard gear of 20 teeth superimposed on a similar gear having a chordal tooth thickness that has been increased 25 per cent or from 0.15691 to 0.19614 in. We see from this illustration that a 10-pitch, 20-deg., 20-tooth pinion with the chordal tooth thickness increased 25 per cent has a strength value of 0.069 or 46¾ per cent greater than that of a tooth of standard thickness. The question of increased tooth thickness involves several other factors of too extended a nature to be dealt with here.

TABLE II—EFFECT OF INCREASED PRESSURE ANGLE ON BEARING LOADS AND BEARING THRUSTS

Pressure Angle	Secant of Pressure Angle	Percentage of Increase in Tooth Pressure	Tangent of Pressure Angle	Percentage of Increase in Bearing Separating Thrusts
14° 30′	1.0329	100	0.2586	100
17°	1.0457	101.2	0.3057	118.2
20°	1.0642	103	0.3639	140
22° 30′	1.0824	104.8	0.4142	160
24°	1.0946	105.9	0.4452	172
27° 30′	1.1274	109.1	0.5205	201.2
30°	1.1547	111.8	0.5773	223.2

This subject, however, will be more fully explained later.

(2) *Decrease in the addendum.* One of the advantages of the 20-deg. stub-tooth gear over the 14½-deg. full-length tooth, is that the addendum is shorter in proportion to the pitch and, incidentally, the pressure angle is also greater. These two factors when combined make a pinion of 20-deg. stub-tooth form considerably stronger. For example, a 12-tooth pinion of stub-tooth form, 20-deg. pressure angle, is approximately 75 per cent stronger than a standard 12-tooth pinion of 14½-deg. pressure angle.

In Fig. 1, view *C* shows a shortened addendum tooth superimposed on the standard tooth we have under investigation. The strength value is 0.063, showing that by shortening the addendum 25 per cent, we increase the strength of the tooth 34 per cent. The only thing to look out for when decreasing the addendum, is to see that continuous action results, and that there are at least one and a quarter teeth in mesh. In other words, the actual length of tooth contact should be equal to at least 1.25 times the normal pitch.

Normal and Circular Pitch

In Fig. 2 is explained the difference between the normal and circular pitch of a gear tooth. The normal pitch is the distance from the face of one tooth to the face of the next tooth measured along the line of action. It is evidently equal to the circular pitch as measured on the base circle, and is found by multiplying the circular pitch by the cosine of the pressure angle. An analysis of this particular case shows that a decrease in the length of the addendum of 25 per cent would produce a tooth which, while it would not fail for continuous action, would, however, fall short of the best requirements. In this particular case the length of the line of contact is only 1.12 times the normal pitch.

(3) *Increase in the face width.* An increase in the face width would increase the strength of the tooth an amount proportional to the increase in the face width. This point is self-evident and requires no diagrammatical demonstration. In addition, however, to increasing the strength of the tooth, an increase in face width also increases the life of the gear and its ability to resist the crushing of the tooth's working surface.

(4) *Increase in the diametral pitch.* To increase the diametral pitch with this particular ratio and still retain the same center distance, it will be necessary, of course, to change the number of teeth in the pinion, the length of the addendum and the tooth thickness. These elements must be made proportional to the increase in the pitch. Increasing the diametral pitch, as shown at *D* in Fig. 1, from 10 to 7.5, which is an increase of 25 per cent, decreases the number of teeth from 20 to 15 and gives a strength value of 0.058, or 23.5 per cent greater than the standard tooth.

As was previously mentioned, an increase in the pitch does not increase the efficiency of the gear, and in this particular case, if the increase in the pitch necessitated bringing the teeth down to 12 in number, there would not be the same proportional increase in strength. A 12-tooth pinion of this pitch would be slightly undercut, which would reduce its strength value.

(5) *Increase in the pressure angle.* Now, if we increase the pressure angle 25 per cent, or to 25 deg., and leave the other elements of the tooth unchanged, we increase the strength value to 0.054, or approximately 15 per cent. It will be noticed at *E* in Fig. 1, that the standard addendum is of sufficient length so that the pressure angle can be increased without unduly shortening the length of the line of contact. The only practical disadvantage to an increase in the pressure angle is that it increases the tooth pressure and the consequent load on the bearings, but not to the extent that is generally supposed. The relation between the tooth pressure and the tangential force is shown diagrammatically in Fig. 3. The line *AB* represents the tooth pressure both in magnitude and direction. This pressure line *AB* makes an angle with a tangent to the pitch line equal to the pressure angle.

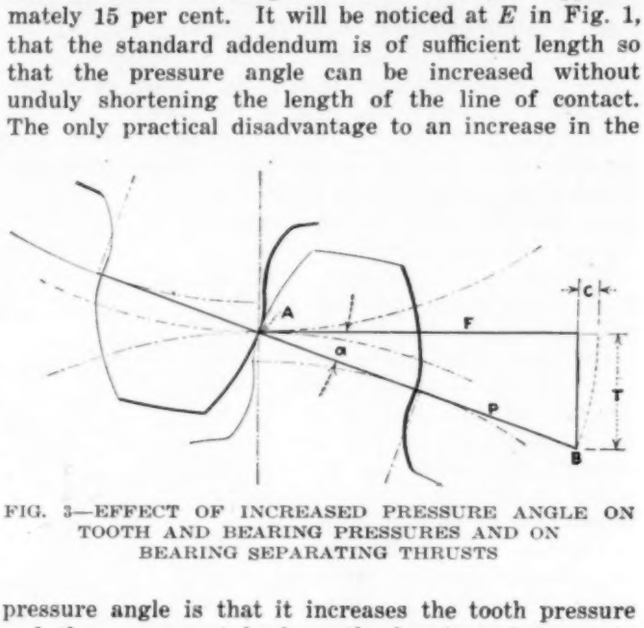


FIG. 3—EFFECT OF INCREASED PRESSURE ANGLE ON TOOTH AND BEARING PRESSURES AND ON BEARING SEPARATING THRUSTS

The tooth pressure has two components, *F* and *T*. The component *F* is tangential to the pitch circle, and *T* is at right angles to it. *F* is the "useful" pressure or tangential force, whereas *T* is the component tending to force the shafts apart, and *C* represents an increase in the tooth pressure due to the pressure angle. From the geometry of the figure, we get

$$F = P \cos a$$
$$T = F \tan a$$
$$P = F \sec a.$$

In other words, the tooth pressure *P* is equal to the tangential load times the secant of the pressure angle, whereas the radial pressure tending to force the shafts apart is equal to the tangential force *F* times the tangent of the pressure angle.

Now, it will be seen from this explanation that the load on the bearings is not equal to the radial force *T*, but is equal to the tooth pressure *P*. This load is the reaction of the action represented by the tooth pressure, and is equal to it and in the opposite direction. Table II gives a comparison of various pressure angles with the 14½-deg. angle. Here it will be seen that up to a

TABLE III—PERCENTAGE OF INCREASE AND DECREASE IN STRENGTH

Obtained by changing one tooth element and bringing the others to agree with standard tooth form when the center distance remains the same.

Example No.	Diametral Pitch	No. of Teeth	Face Width Inches	Pressure Angle in Degrees	Addendum in Inches	Tooth Thickness in Inches	Value of *x*	Percentage of Increased Strength	Remarks
..	10	20	1	20	0.100	0.15691	0.047	....	Problem given
1	10	20	1	20	0.100	0.19614	0.069	46.75	Chordal tooth thickness increased 25 per cent
2	10	20	1	20	0.075	0.15691	0.063	34	Addendum reduced 25 per cent
3	10	20	1.25	20	0.100	0.15691	0.047	25	Face width increased 25 per cent
4	7.5	15	1	20	0.133	0.20905	0.058	23.5	Pitch, No. of teeth, addendum and tooth thickness changed
5	10	20	1	25	0.100	0.15691	0.054	15	Pressure angle increased 25 per cent
6	12.5	25	1	20	0.080	0.12557	0.039	15.75*	Pitch, No. of teeth, addendum and tooth thickness changed

*Reduced strength.

pressure angle of 30 deg. the increase in tooth pressure and the consequent increased load on the bearing are not excessive. The separating thrusts are however much higher as the pressure angle is increased.

(6) *Increase in the number of teeth.* An increase in the number of teeth combined with a decrease in the diametral pitch, decreases the strength of the teeth, as diagram *F* in Fig. 1 clearly illustrates. The only advantage gained by increasing the number of teeth, is that it brings a greater number of teeth into contact with a resulting greater efficiency. The life of the tooth, however, can be more satisfactorily taken care of by an increase in the face width. In addition to being shown diagrammatically in Fig. 1, the results are summarized in Table III, having been obtained by varying the different elements.

Getting Men for the Machine Industry—Discussion

By A. W. Forbes

"Although there are vocational schools in nearly all localities training boys for industry, they are not mentioned in your editorial, and in fact, they are rarely mentioned when a shortage of skilled labor is discussed." This quotation appears in an article with the above title on page 540, Vol. 58 of the *American Machinist*. I have often noticed the same fact and have wondered why it was so. Is this omission a deliberate slight to the schools? If it is, I should think it would be more courteous to come right out and say that they do not consider the vocational schools a success, as I have done frequently, rather than to ignore these schools and urge employers to do the same thing. Or have these writers on apprenticeship been so interested in their particular training that they have failed to see that others were trying to accomplish the same result in another way?

Mr. Harper in the same article explains the theory of the vocational schools, and why they should produce better all-round men for the industries than taking the boys directly into the industries. His argument sounds good, even to the statement, "If the above facts are true, and I believe them to be true, should not employers everywhere take a larger interest in vocational schools?"

But as a rule employers don't, as shown by the article to which Mr. Harper refers, and the employers know a little about what makes desirable employees, even if they do not know as much as they should about the subject. An observation on employers' attitudes would lead to the conclusion that the vocational school is not as much of a success as Mr. Harper would have us think. I want to bring out one possible explanation, which at most is but a contributing factor to the subject under discussion.

Quoting again, "In the first place the shop teacher has qualified for his position by passing a written, practical and oral test. To qualify for the examination he must be an all-round journeyman, with at least five years experience, and a high school education or its equivalent." He is here referring to the shop teacher in a vocational school.

First the high school education. I find that there are many other employers who have reached the same conclusion that I have, that a high school graduate is not good material from which to make an all-round journeyman. The all-round man should start younger. But suppose we have found one who is, and that after five years experience he is making good. What is the chance that he will apply for a position as teacher in a vocational school? Why should he try a new line of work if he is making good where he is, for teaching in a vocational school is a new line of work even if it is the same trade? The school may offer an immediate advance in pay, but it certainly cannot offer equal opportunities for advancement in the future.

Some of the teachers seem to agree with me in regard to this last statement, for the last time I tried trade school graduates, two of the teachers came to see if the work I was offering to the boys would not be satisfactory for them.

I am not trying to criticize all the teachers, for there are some excellent teachers in vocational schools, but I doubt very much whether it would be possible to secure a teaching force for a vocational school equal to what can be obtained in the industries, where the management is making a real effort to provide a satisfactory form of apprenticeship. This will at least be the case, as long as the schools are prevented from hiring the best men available by such restrictions as Mr. Harper mentions.

Solving the College Man Complex

By Harry Botsford

A group of executives were having lunch together at the Chamber of Commerce in Pittsburgh the other day and they were discussing the complex surrounding the modern college man. A consensus of opinion seemed to bring forth the general opinion that the modern college man represented a puzzling problem to business industry. As a rule he did not care to accept a position unless it carried with it a highly polished desk and considerable authority. In nearly 90 per cent of the cases, these executives held that the college graduate was not fitted for such a position—he lacked experience, seasoning which gives a man sound judgment. It was further brought out that the turnover of college graduates was extremely high—too high. Most of them left or desired a change of work before they had time to become acclimated and thoroughly seasoned to the work in which they were engaged.

A prominent steel man spoke up. "We haven't had a bit of trouble with our college men," he stated, "in fact we have a large number of them in our organization and they are all comers, too. Two years ago we faced exactly the same problem you gentlemen have been discussing. We took a new tack. We decided to hire only those college men who worked themselves through college. It was one of the most important decisions we have ever made! We're sold on the idea that the young fellow who has the courage to work his way through college is made of the right stuff. He has had all foolish ideas rubbed off by contact with a world where he must earn his own way. If he earns the money which pays for his education he is going to see that he gets value received. We have found that the type of young fellows who work their way through college are far better educated than those who have not. Further than that they are always willing to accept a position pretty near the bottom of the ladder but we have yet to find one who stays there—they are getting ahead by sheer ability."

Standardization of Machine Tools

By J. A. Smith
General Superintend nt, General Electric Company, Schenectady

This is an age of Standardization, and we hear a great deal about various standardization committees, some of which are organized by different departments of the Government and others by the various engineering societies. Considerable work has been, and is being accomplished by different engineering societies, organizations and committees, and very broad claims have been made as to the increasing efficiency of machine tools, apparatus and equipment as a result of the investigations, studies and recommendations of the various bodies. Many of these claims are for the standardization of machinery and apparatus outside of the machine tool industry to which I would like to confine this article.

In the machine tool field a great deal of excellent work has been done, and much more of a similar character is either in process or in contemplation. I would like, however, to briefly call attention to one or two points of machine tool design upon which, either through accident, intention, or difference of opinion as to policy, less work of a constructive nature has so far been accomplished than would seem necessary.

Lubrication and Repair Bills

Taking the so-called common general application of machines as a basis it is my belief that while performance, capacity and convenience have been given a great deal of serious thought the subject of lubrication has not been given the consideration it should, nor has it reached a point where it can be regarded as entirely satisfactory. While this does not apply to machines made by all manufacturers, it is still a subject which should receive further consideration.

It is the experience of a great many users of machine tools that a large portion of their repair bills are due to the failure of the lubrication system to function as it should, and while it is only fair to state that some of the trouble may be due to carelessness of operators, it is a fact that in many instances the location of oil holes, or their small size, is such as to render it almost certain that they will at times be overlooked, with the result that moving parts will be damaged.

Another situation which is the cause of a great deal of inconvenience and unnecessary expense is the failure to standardize certain parts of lathes and milling machines at the points where such tools as chucks, fixtures and cutters are to be applied.

The standardization of parts has been very completely covered by manufacturers of drill presses, where the use of the Morse taper is practically universal, but in the case of lathes there seems to be no uniformity in the sizes of tapers used for machines of corresponding size. Worse still is the failure to standardize spindle ends, as nearly all machines not only vary materially in design and construction between similar sizes, but between different sizes of machines made by the same manufacturer.

This failure to standardize spindle ends entails very heavy expense for chucks—in some cases special fixtures—or compels the purchaser to specify that all machines in a department or plant shall be obtained from one maker, which is manifestly impossible, particularly in the case of larger users. Even this arrangement would not cover the situation, as it is frequently desired, due to changing conditions of manufacture, to transfer machinery from one department which may be underloaded, to one where the load is in excess of present equipment, or for similar reasons to another plant.

The failure to standardize parts is also noticeable in the case of milling machines where practically all manufacturers have standardized on Brown & Sharpe tapers in the spindle, and in the case of universal milling machines in the dividing head, and further, standardized table slots for the reception of vises and other appliances, but have so far failed to standardize the exterior of the spindle end where facing milling cutters and other similar equipment must be applied.

Expense of Unnecessary Cutter Duplication

This lack of standardizing spindle ends results in enormous expense either in the unnecessary duplication of cutters, or the make-shift arrangement of using adaptors which are very unsatisfactory for many reasons and very frequently are the cause of the machines failing to give the results expected of them due to faulty application which may be necessary in order to meet production requirements.

So far as standardization is concerned there is, in the judgment of the writer, no place where more good could be done for the machine tool industry than by looking into some arrangement among milling machine manufacturers whereby the spindle ends should be made standard for common sizes of machines.

The writer has no particular preference for any design of spindle end, but believes that in the interest of efficiency, economy, and ultimate good of not only the users, but manufacturers of milling machines, this subject ought to be given prompt and serious consideration. It seems peculiar that where there does not apparently exist any insurmountable difficulty in obtaining uniformity of practice with reference to weights, travel ranges and capacity generally—not to say anything about prices—this subject has not been given attention before this.

An Interesting Vacation Plan

By Wm. J. Fisher

It has always been pleasant to read in the *American Machinist* about the vacation plans and bonus offers that different corporations give to their employees, and I thought perhaps the vacation plan that we have in the shop in which I am foreman might be of interest.

Our offer is that if an employee works fifty-one weeks in the year he is allowed one week vacation with full pay. If he needs his vacation week's pay in advance, he can have it by notifying his foreman. Now there are some excused absences during the fifty-one weeks' work. Should there be a death in his immediate family, he must cut the funeral notice from the local paper and give it to his foreman, who signs it and gives it to the time office. Or, if he is sick, he must bring a doctor's certificate for the time he is away.

During the time it has been in effect a large number of the men have earned their vacation, and have apparently enjoyed it, and been benefited by their rest. Of course, we cannot give the vacation to all the men at the same time, the time being set by the foreman who consults with the men and tries to make it agreeable to both sides.

Fabricating Large Steel Pipe

By ELLIS H. CUSTER

Plate edges beveled in rotary shearing machine — Rivet holes drilled by jig—Press and dies used for curving plates—Riveting and calking

MAKING the steel pipe for the Bryn Mawr, Fort Hill, Kensico and Elmsford siphons of the New York Water system presents some problems in shop work that are of unusual interest.

The plates used are of three thicknesses, $\frac{7}{16}$, $\frac{1}{2}$ and $\frac{9}{16}$ in., the $\frac{7}{16}$-in. plates being used for the greater part of the work, while the $\frac{1}{2}$- and $\frac{9}{16}$-in. plates are used for the lower parts of the gradients where the pressures are heaviest.

The plates are rolled at Sparrows Point, Md., but the actual fabrication into pipe is done at the plant of the New York Engineering Co., within a few miles of the field of construction.

The plates are 35 ft. 6 in. long and weigh over two and one-half tons, each plate making a half section of pipe 11 ft. 3 in. in inside diameter and a length of 7 ft. 6 in. when assembled. In so far as the shop work is concerned all the operations are identical, with such exceptions as the number of plates handled at one time in drilling and bending.

Upon arrival of the plates at the plant they are cut

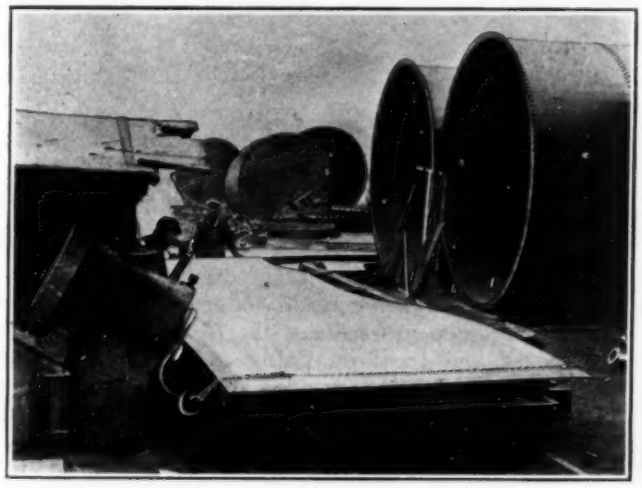


FIG. 1—BEVEL-SHEARING EDGES OF PLATES

to width by bevel shears as shown in Fig. 1. This operation provides the sides with calking edges. The next operation is scarfing, after which the plates are pickled to remove the scale. Pickling is done in a large tank in a 5 per cent solution of sulphuric acid and water, heated to a temperature of 125 deg. F. The plates are next dipped, first in fresh water and then in warm lime water to neutralize the effects of the acid in the pickling bath.

The rivet holes in the plates are jig drilled, the plates being placed upon a rolling table where they travel between radial drilling machines, as shown in Fig. 2. The $\frac{7}{16}$-in. plates are stacked six high and have 434 holes drilled in them for lap riveting. The heavier plates are butt riveted, being stacked five high and have 590 holes. The holes are all $1\frac{1}{16}$ in. in diameter and from 4 to $4\frac{1}{2}$ hr. is required for the drilling

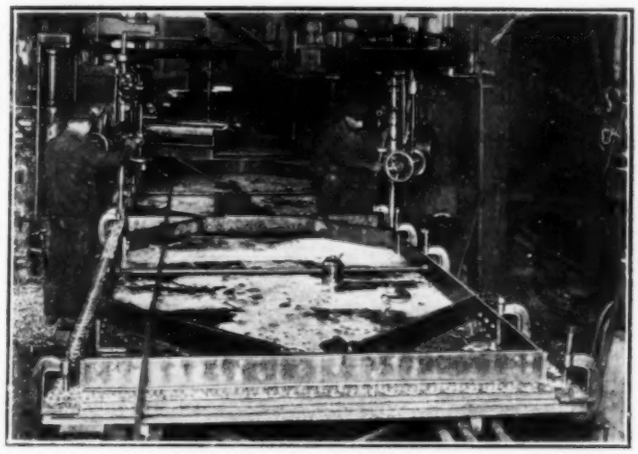


FIG. 2—DRILLING THE PLATES

of each stack. Lubricant is furnished to the drills by a pump, after which it flows back to a well. The drilling is accurate enough to make the plates interchangeable and, considering the small amount of reaming and drifting necessary in assembling, it is cheaper than punching.

After the plates have been drilled they are taken to the bending machine where they are bent to the proper curvature, the $\frac{7}{16}$-in. plates being bent two at a time while the heavier plates are bent singly. The bending operation may be seen in Fig. 3. The work is done between dies in a Norwalk squeezer. The lower edges of the plates rest on small trucks as at *A* and are advanced between the dies 7 in. at each stroke of the machine, being moved by a winch the cable of which is attached at one of the rivet holes. This method of bending has been adopted in preference to the usual one of bending in rolls as the curvature of the plates extends to the extreme edges, while if bent in rolls there would be a certain distance from the edges that would remain flat. This flat portion would have to be "flogged" to the proper curvature or the pipe would not be round.

From the bending machine the half-sections are taken to a hydraulic riveter for lap or butt riveting the longitudinal seams, as the case may be, lap riveting

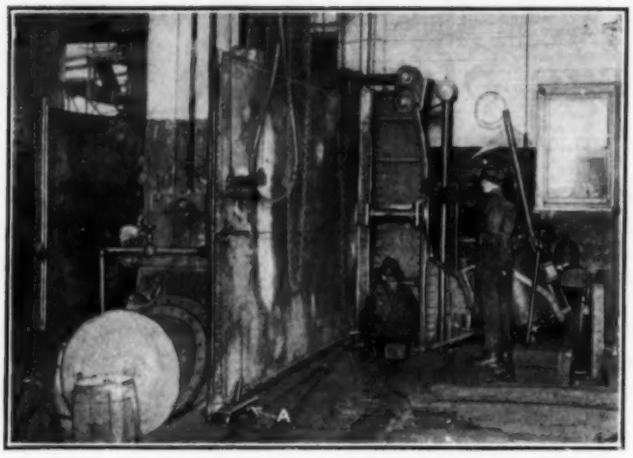


FIG. 3—BENDING TWO $\frac{1}{16}$-IN. PLATES SIMULTANEOUSLY

being used for the lighter pipe and butt riveting for the heavier pipe. From there the sections go to a pit for assembly. First the outside shell is lowered into the pit, then the inside shell is put in. Thus assembled into a street section, they are returned to a bull-riveter to rivet the two sections together as shown in Fig. 4. The location of the riveting ram is on an elevated platform, on which is also placed a Berwick electric rivet heater. The pipe, suspended on a level with the platform, turns easily on a swivel overhead, under the control of the ram operator or helper. The electric heater is a five-rivet unit, so that heating and driving the rivets proceeds steadily, maintaining an average of about 175 rivets per hr. The heater is capable of heating 366 rivets per hr. and its operation is said to be very economical and satisfactory.

From the riveter, the street-section is brought back to the assembly floor and there calked inside and out, the outside calking being shown in Fig. 5. A section of pipe, when completed, is covered with boiled linseed oil on the outside and whitewashed on the inside in order to protect it until it is ready to be assembled in the field. These street-sections, weighing 5 to 7 tons, according to size of plates used, are loaded at the works on 7½-ton Mack trucks and taken out to the line, where the sections are riveted together into one continuous length. While in transit and when laid on the concrete cradle in the trench, they are protected by tension bars. There is one other operation on the calking floor. In each pipe is a 2-in. flange for the grouting connection or aperture through which cement grout is allowed to flow after the pipes are laid, in order to form the 2-in. ring of concrete with which the inside is lined. The grout-hole pad is hand-riveted to the highest part of the pipe and the calking is done by hand on the assembly floor.

Each elbow of the siphon is laid out by itself. The sheets for the elbows are drilled in the same way as the pipe sheets but not in multiple. They are bent the same way in the vertical press. A 2-deg. elbow presents one set of problems while a 3-deg. elbow presents another set. To assemble a 2-deg. elbow may take as long as 3 hr., while an ordinary straight section of pipe may be assembled in about 45 minutes.

On account of the flexibility of fabricated pipe, even of the extreme thickness of plate here concerned, the pipe is put under pressure as soon as it is laid and before the concrete jacket is put on. When tested for leakage and after being made watertight, the pouring of the concrete is proceeded with. Afterward the head is removed and the 2-in. lining of cement is put in though the grout holes provided at the tops of the pipe sections. The present state of the work is that considerable concrete jacketing has been done, but the grouting for the inner lining will be done later the coming summer.

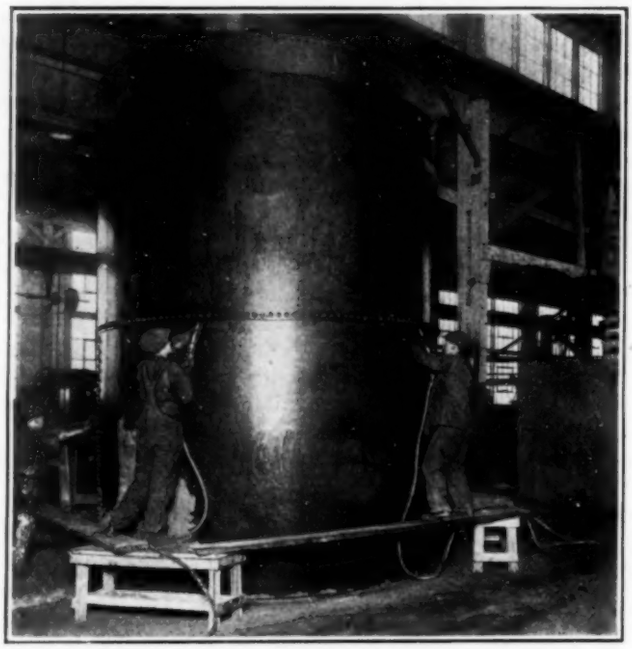


FIG. 5—CALKING THE JOINTS

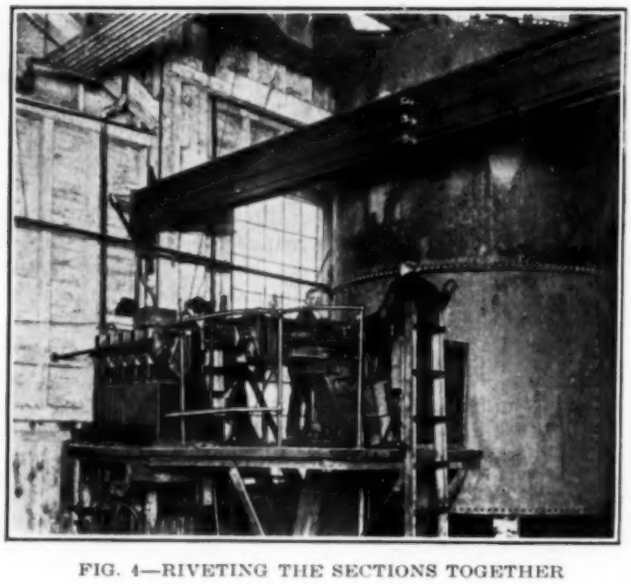


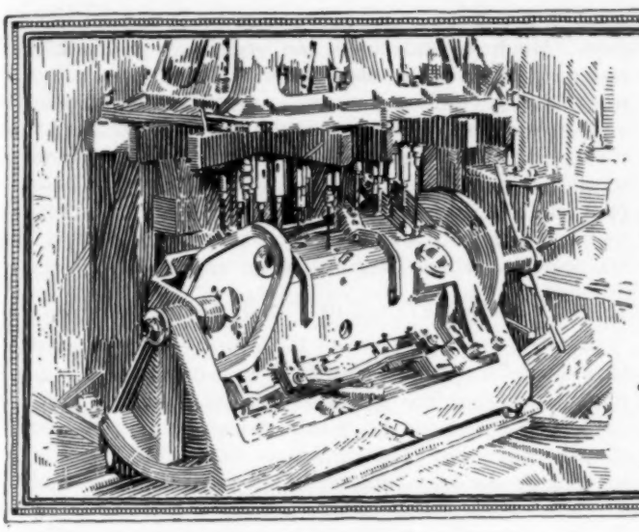
FIG. 4—RIVETING THE SECTIONS TOGETHER

An Inverted Engine

An upside-down aero engine, constructed for a two-seater fighting aeroplane, has been tested in the Napier works at Acton, Middlesex, England.

The engine, which is known as the inverted Napier "Lion," is an exact reversal of the ordinary engine, having its crank case at the top and its cylinders beneath, and has been so constructed as to enable the pilot of a fighting plane to have an uninterrupted view forward of his machine.

The engine developed a full 450 hp. at the test.



Tool Engineering

By
Albert A. Dowd and Frank W. Curtis
President and Chief Engineer
Dowd Engineering Company, New York City

Design of reference and work gages — Important points in gaging work —Suiting the gaging system to the work — Limit plug and taper gages

THERE ARE THREE distinct groups into which gages of all kinds may be separated, *viz.*, reference, work and inspection gages. In each of these groups are different types of gages usually designated by terms which are derived from the purposes for which the gages are used, the shape or style of the instruments, or from the method of application of the gages to the work. The lines between the groups are not always clearly defined in so far as the general use of the gages is concerned, as obviously the same type of gage may often be used for both work and inspection conditions. In separating them we shall try to illustrate their use in such a way that there will be no dissension regarding their function and application.

Methods in Modern Gaging Practice

Modern gaging practice shows a distinct gain over the methods in use a few years ago, and many varieties of gages have been to a certain extent standardized so that they can be purchased cheaply when needed. The introduction of alloy steels and those which do not change greatly or distort when hardened have greatly assisted gage makers by simplifying methods of manufacture. Greater accuracy is also possible as the result of refinements and improvements in machine tools used for the work. Measuring instruments have been perfected to a great extent. All of these matters have a bearing on the design of gages and the accuracy which can be obtained in manufacture.

There is a prevailing tendency on the part of manufacturers to use, as far as possible, gages which are adjustable for wear and also those which give the workmen some idea of how closely he is approaching the limits of manufacture within which the work must be kept. With reference to the latter statement, indicators are often used, and many of the standard types of indicators can be applied to instruments used for the purpose of gaging. The advantages of adjustable gage points are self-evident as settings can be readily made to compensate for wear. Gages which make the operator's work easier by showing him how closely he is approaching the limits which have been set, are superior to those which simply establish the high and low limits to which the work must be held.

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When it becomes necessary to design a set of gages for a given product a broad-minded view of the situation must first be obtained, in order to establish a gaging system which will cover the situation thoroughly from the time when the rough stock reaches the factory to the final completion of the mechanism ready for delivery. There are a number of general points which

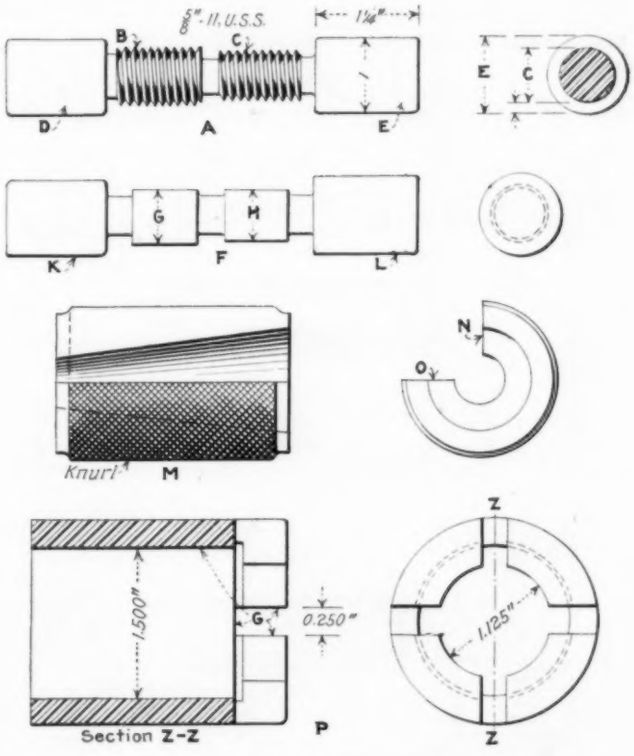

FIG. 526—EXAMPLES OF REFERENCE GAGES

apply to work of this character, and they are stated here briefly. Other matters which cannot be readily covered in general notes will be treated specifically later.

(1) *Gaging of Rough Stock, Castings or Forgings.*—If bar stock is to be used in manufacture it may often be found that a preliminary gaging of the stock will

save considerable trouble by making sure that the material is within the limits specified for the work. So also the quality of the material should be known, and in some cases tests are necessary in order to make certain that it is up to the specifications. Castings and forgings should be inspected for distortion before placing in the shop and sometimes parts of this kind may require a straightening operation before they can be used. Inspection gages for rough castings can be made with wide limits to show whether or not any parts are too badly distorted to be used. Frequently gages of this sort are of simple form, except when required for intricate castings which are likely to have been so distorted that they will not produce finished work within the required dimensions.

(2) *General System Used.*—A great deal depends upon the size of the factory and the methods used in production, as one shop may be dealing with a product requiring very careful inspection between operations, while in another factory a high degree of accuracy may not be required, so that a simpler system can be used without trouble. The planning of a gaging and inspection system requires a broad experience in this line of work, and the number of inspectors necessary is dependent very largely upon the size of the factory and the product manufactured. In general it may be said that for mechanisms requiring a high degree of accuracy, the system of gaging should be such that the parts are inspected after each operation. Unless this is done, subsequent work may also be found inaccurate due to original errors in manufacture, and thus a number of parts may be "scrapped" when they could have been saved by careful inspection after the first operation.

(3) *Determining Limits for Work and Inspection Gages.*—Some factories make their inspection gages

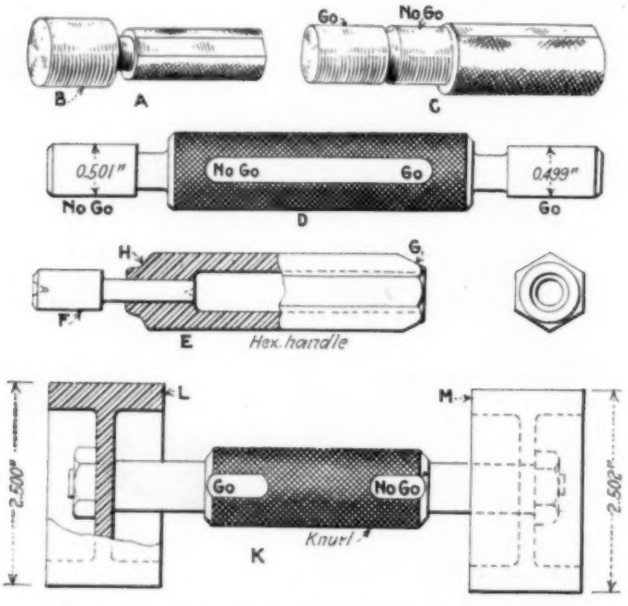

FIG. 527—EXAMPLES OF LIMIT PLUG GAGES

with slightly larger limits than the work gages, as when this is done the inspector has more latitude than the workman. Thus work which has been made a small amount over or under size by the workman may occasionally be saved in the inspection department. This practice of placing different limits on work and inspection gages is not universally followed, but there are cases when such a procedure may be found an advantage. Much depends upon the organization and supervision of the various departments with respect to the work gages which are in use. A system of inspection of gages is always important in order to make sure that those which are in every-day use have not become worn so that the specified limits are exceeded. With a carefully planned system of inspection the gages are checked up periodically to make sure that they are correct for the work on which they are being used.

The Importance of the Time Element

(4) *Number of Pieces to Be Gaged.*—In high production work the time element is an important one, no matter whether the gages are to be used for work or inspection purposes. For this reason the design should be carefully studied with a view to making the process of gaging as easy and rapid as possible. On certain kinds of work the method of applying the gage may be found very awkward for the operator unless sufficient thought has been given to the design with the idea of simplifying the method used. In the case of turret lathe work or work on boring mills when work gages are needed, those gages which would be heavy and difficult for the operator to handle if made from steel or cast iron, may often be lightened and made more convenient by the use of aluminum, suitably re-inforced if necessary. For work on the milling machine it is often possible to devise a fixture on which a suitable gage can be mounted in such a way that it can be swung into place and used rapidly. There is no precedent which can be given that enables a designer to decide what method is best, but by placing himself in the operator's position when designing work gages he will be able to analyze the requirements of the work and adapt his gage to the conditions.

(5) *Upkeep and Wear on Gages.*—There is always a certain amount of wear on gages, and wherever possible this fact should be provided for by designing the gages so that replacements of worn parts can be made when necessary. There is a great deal of difference in the wear on different types of gages, and it has been found by experiment and careful records that plug and ring thread gages wear more rapidly than any others, due to the amount of frictional contact when using them. Cylindrical plug gages do not wear as rapidly as thread gages, and the life of snap gages is considerably greater than that of plug gages as the abrasive action occurs on only a line contact on the anvils of the gage.

Tests have shown that the relative lives of thread, plug and snap gages are approximately as follows: Considering thread gages as one, plug gages will wear about six times longer and snap gages approximately twenty-five times longer. In addition to the wear determined by the type of gage used, we must also consider the material on which the gages are utilized. There is more abrasive action in some materials than in others, and it has been found that gages used on aluminum wear more rapidly than those used on cast iron, in the proportion of about 2 to 1. Gages used for brass work will last about five times as long as those used on aluminum. It is evident from these statements that the number of gages required for a given number of pieces would be determined to a great extent both by the type of gage and by the material on which it is used. These matters must all be considered when designing gages and specifying the number required.

(6) *Material for Gages.*—The character and nature

of the work to be gaged has a controlling effect on the material used. Many manufacturers contend that machine steel properly carbonized and hardened is a satisfactory material for certain types of gages, yet another manufacturer believes that nothing but tool steel should be used. Alloy steels or non-shrinking steels can usually be utilized to advantage when making templet gages or other gages of such a shape that they would be likely to change considerably in hardening. Gages used for reference are often left soft, and yet some manufacturers do not believe in this method but think that they should all be hardened, ground and lapped because of the possibility of their becoming bruised or otherwise injured in handling. It can be stated that there does not seem to be any standard practice in regard to the material itself or its treatment for use in gages, as there are a number of matters to be considered for each particular case, all of which affect the situation so that it is difficult to decide without knowing the conditions thoroughly.

For snap gages the frames are often made of cast iron on account of the rigidity obtained. There is an additional point of advantage in using this material as a gage may be dropped on the floor and it may break, but if made of cast iron it will certainly not bend nor become distorted. All of these matters are important and call for judgment on the part of the designer.

(7) *General Data.*—In considering the design of gages for a certain part the matter should be thought of in a broad-minded way and every effort made to design the gages so that they will be as nearly as possible "fool proof." The strength of the gages and their resistance to abuse must be fully considered, and the operator's convenience must also be carefully thought of. By so doing the gages when completed will reflect credit upon the designer.

Reference Gages

Gages which are used only for determining sizes of other gages or for setting instruments used for measuring are termed reference gages. The distinction between a reference gage and a work gage is not always clearly defined and occasionally an attempt is made to use a reference gage in the inspection of work. This should not be done as it causes wear on the gage, and therefore changes may occur which will invalidate it for reference purposes. Nearly all gages are hardened, ground and lapped; but for reference purposes they are occasionally left soft in order that errors caused by hardening do not need to be corrected. It depends largely upon the type of gage used as to whether it is well to harden it or not, and there is some difference of opinion on the subject. Reference gages for threaded work are often left soft, because the threads are likely to be distorted somewhat if hardened. Naturally, any gage which is left in a soft condition must be very carefully kept in order that it will not become bruised or battered when used.

We may consider that simple plug and ring gages made to standard sizes are reference gages. So also are end measuring rods, size blocks, disks, etc. Gages of this sort should not be used for measuring, but rather for setting instruments by means of which measurements can be taken. In the manufacture of tools and gages, Johansson blocks are invaluable accessories as by means of these blocks the greatest accuracy can be obtained. We are not, however, concerned greatly with the use of end measuring rods, size blocks and the like, except as their application is made to the work itself. It is always an advantage to understand the application of gages and blocks of this sort. The principal purpose of a reference gage is to provide fixed dimensions by means of which both inspection and working gages can be checked occasionally in order to counteract the effects of wear. The tool designer is not frequently called upon to design reference gages, but it is necessary for him to understand how they are used

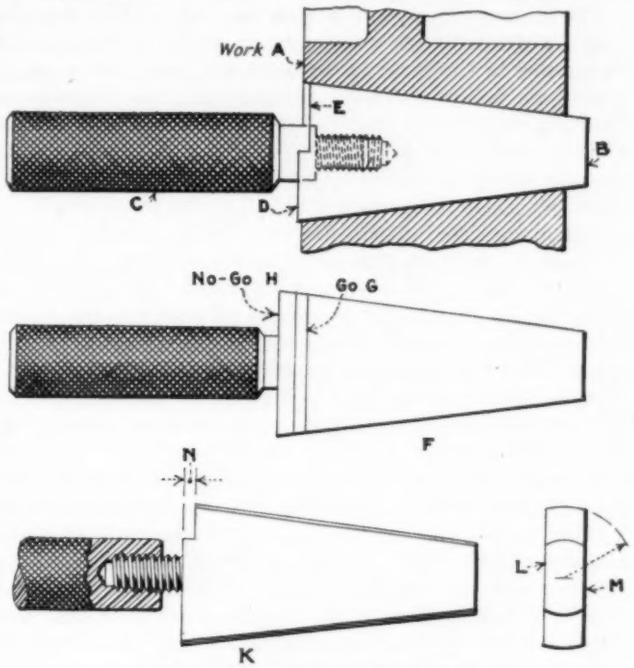

FIG. 528—TAPER PLUG GAGES

and at the same time realize their importance. Any gaging system must have some means of checking at stated intervals the various gages used, as the wear on certain kinds of work causes rapid changes in the sizes and these variations must be corrected very frequently in order to maintain the sizes desired.

We have shown a few examples of reference gages in Fig. 526, all of which are of simple types. The thread gage shown at *A* is a soft gage on which two sets of threads are cut at *B* and *C*. These threads are made to the sizes which represent the maximum and minimum limits on the work. The ends of this gage at *D* and *E* are made somewhat larger than the thread for two reasons, one of them being to give protection for the thread and the other to prevent screwing a piece of work on the thread and thus injuring it. Gages of this kind are sometimes provided with cylindrical surfaces to represent the outside diameter of the thread, as well as the root diameter.

Reference gages for setting snap gages are occasionally made like that shown at *F*, but when made in this manner they are usually hardened, ground and lapped. The portions *G* and *H* represent the maximum and minimum limits to which the snap gage points must be set. The ends *K* and *L* may be larger than the center portion if desired, but they should be removable to permit lapping the gaging surfaces.

A reference gage for taper plugs is shown at *M*. This gage is cut away at *N* and *O* so that the line of contact between the plug gage and the inside taper surface may be readily seen when checking the plug for accuracy. The example shown at *P* is a spline reference gage of the female type which is used for check-

ing up a male gage by observing the contact obtained on the splines. The diameter 1.500 in. can be checked at the same time, as well as the dimension 1.125 in. This type of reference gage is also used as a work gage, but the one used for reference should always be made slightly different from the work gage and clearly stamped "Reference."

Designing Reference Gages

There are numerous other examples of reference gages which could be given; but as many of them would be similar in their characteristics to those used as work gages, we believe it is unnecessary to show them here. The principal point that the designer must consider in making reference gages is that the gage itself should be used simply to check other gages or sizes and should never be utilized in connection with the work itself.

When considering the design of gages which are to be used on work in process it is evident that the character of the work, the material used, the number of pieces to be gaged, the machine tool used for the work, the conditions under which the work is produced and some other factors must be considered. We have previously discussed the effect of wear on gages and with the facts given here as a basis, a very good estimate of the requirements can be obtained.

If work is in process on a machine tool and if there is a chance for errors during the machining, it is advisable to design the gage so that it can be used while the work is being held in the machine. If this is done, errors which may have developed can often be rectified by recutting without removing the work from the machine. There are some cases when it is very difficult to apply a gage to the work until after it has been removed from the machine, but this point should always be considered by the designer in an attempt to design the gage so that it can be used before removing the work. If the latter is held in a fixture, gage points can occasionally be applied to the fixture itself. Naturally a great deal depends upon the shape of the work and the surfaces which are to be gaged.

Convenience of the operator should be studied and the gage designed so that it will be easy to handle and to read. When the "sense of touch" is employed, as it often is in gaging, the error in the work should be multiplied in the gage to a sufficient extent so that there will be no doubt about the limits, even with an operator whose fingers are calloused and therefore not sensitive.

Designing Cylindrical Plug Gages

Let us consider first the design of cylindrical plug gages which are used for determining the sizes of holes. Fig. 527 shows several examples of gages of this sort for both small and large diameters. The example *A* is a plain cylindrical plug gage which has no limits whatever. When using this type of gage the operator is dependent entirely upon his own judgment in determining whether the fit of the portion *B* in the hole which is being gaged is too free or too tight. Two operators in using this type of gage may make holes which have considerable variations, because the judgments of the operators as to what constitutes a fit would be somewhat different.

By limiting the smallest size of the hole which is permissible, and also the largest size, a gage like that shown at *C* can be utilized without calling into play the judgment of the operator to any great extent. In this case the gage shown is to be used in an open hole, and therefore the "go" and "no-go" portions can both be made on the same end of the gage as indicated. If the go portion enters the hole and passes into it freely and if it is found that the no-go portion will not enter, it is very evident that the hole has been produced within the limits specified by the gage. Gages of this sort are often made from one piece of steel, with a knurled handle and with the two gage portions ground and lapped carefully to size. As a general thing the go portion is made longer than the no-go for the reason that it must in each case enter the hole. Since the no-go portion does not enter, it does not need to be long.

In the example shown at *D* the go and no-go portions are made at opposite ends of the gage because the hole which is to be gaged is "blind," and therefore the previously mentioned type cannot be used. Gages of this kind are sometimes made in one piece, as shown here, and with a knurled handle. There is, however, considerable economy in standardizing gages by using a handle like that shown at *E* and making up plugs like that at *F* for various diameters. These plugs can be hardened, ground and lapped and forced into place in the handle, or held in position by means of setscrews.

The Gage Handles

The handles can be lightened by drilling them out at one end as shown, and using plugs of different sizes in the two ends; or by drilling the same diameter hole entirely through the handle and reaming enough at each end to fit the shanks of the plugs. The ends of the handle may be chamfered or relieved according to the fancy of the designer or the requirements of the work. The ends are usually tapered as at *G* or relieved as at *H*, in order to avoid a clumsy appearance. Centers should be made in the plugs when this type of gage is used, so that they can readily be ground and lapped to size.

When plug gages are made for small diameters they are not heavy enough to cause the operator any inconvenience, but when sizes range from 1½ in. and upward it is often desirable to lighten the gages as much as possible. Attention must always be paid, however, to the possibility of distortion in hardening, and the plugs should never be relieved or cut away in such a way that the strains set up will be unequal. The example shown at *K* is a double-end gage for a hole 2.500 in. in diameter and having a tolerance of 0.002 in. The plug sections of this gage, *L* and *M*, are cupped out on each side to an equal distance from the edge in order that the chances of distortion in hardening shall be reduced as far as possible. The knurled handle is often made of aluminum or of a steel shell with a wooden or fiber sleeve surrounding it. The two plugs are held on the handle by means of the nuts shown. Gages of this kind may be easily corrected for errors and the handles may be standardized to take a number of different sizes.

Plug gages are the simplest of all forms and yet there are a number of general points in the construction which are of importance. Some of these points have been mentioned in order to give the designer a thorough understanding of the subject. It is possible to purchase plug gages of different sizes at very reasonable prices and in a variety of designs. The manufacturers who specialize on this class of work are many times able to quote prices lower than other factories can do the work for unless they are properly equipped. For this reason it is advisable to use plug gages of a standard type whenever the nature of the work will permit it.

In the design of gages for tapered holes a great deal

depends upon the nature of the fit required. It is customary to determine the fit on the angular tapered portion by means of a simple taper plug long enough to extend entirely through the hole. In order to make sure that the taper is correct, Prussian blue is generally used and inspection of the plug after using it in the hole will show any points of difference between the tapers. In manufacturing work taper holes are usually produced by means of one or more reamers, although a generating process is sometimes used. In either case, however, there is little likelihood of a change in the taper taking place during machining after the angle has once been determined.

Taper Gages for Tapered Holes

In the majority of cases a tapered hole is required to fit a taper shaft and the important part of the fit is the longitudinal position of the work on the shaft, always assuming, however, that the taper itself has been proved to be correct. For this reason taper gages are made to determine the diameter of the hole at the large end, as this dimension would naturally control the position of the work on the shaft. In measuring the diameter of a taper hole, the easiest way to find out whether it is within the limits required is to use a shouldered taper plug in the hole, inspecting its longitudinal position with respect to the shoulder and thus fixing the large diameter of the hole.

The angularity of the taper makes a great difference in the longitudinal position of the work, and it is evident that for each 0.001 in. in diameter of the hole the longitudinal position changes an amount which is dependent upon the taper. For example, a very shallow taper such as 0.0625 in. per foot requires a longitudinal movement of 0.192 in. for each 0.001 in. of change on the diameter. In taking an extreme condition where the taper per foot is 1.500 in. the longitudinal movement corresponds to 0.001 in. on the diameter is only 0.008 in. On account of these factors the greatest care must be used in setting tolerances on taper gages, and while the tool designer himself may not often be required to establish tolerances, it is well for him to note the importance of the points just mentioned.

Designing Taper Gages

In Fig. 528 are shown a group of tapered plug gages of simple construction, and various methods of designing and establishing limits. The work shown at *A* has a tapered hole in it and we assume that the angularity of the taper has been previously determined. It is necessary to determine the diameter at the large end of the hole by means of a taper plug gage like that shown at *B*. This gage is made up to the correct taper and provided with a handle, *C*, which may be applied in any approved manner. The gage is cut away to form shoulders at *D* and *E*, which shoulders are established so that the mean diameter of the hole will come between the two. Thus the operator in using the gage needs only to apply it and ascertain that the shoulder *D* is above the surface of the work and that at *E* under the surface. If these two conditions have been fulfilled he will know that the work produced is within the required limits of accuracy. In the example shown at *F* another method of making the shoulders is indicated. Here the go portion *G* and no-go portion *H* are on the same side of the gage, a small shoulder only being made. If taper gages are of small diameter or shallow taper it may be found economical to make up the tapered portion and the handle from one piece. If large and heavy, an aluminum handle or one of fiber may be found an advantage.

Another method often used for tapered plug gages is shown at *K*. In this case the tapered plug is cut away on the sides as shown at *L* and *M*, partly in order to lighten the gage and at the same time to give it less area of contact. The shoulder representing the tolerance is cut on one side of the gage as shown at *N*. The handle in this case is screwed on as indicated. Care must be taken to avoid gages which are heavy and cumbersome, as they are difficult to use and the operator's sense of touch is very much hampered if the gages are too heavy.

The Job That Was Too Big for the Planer—Discussion

By J. T. Towlson
London, England

On page 190, Vol. 58, of the *American Machinist* F. M. A'Hearn describes a job that was too wide for the planer, and the very ingenious way in which the difficulty was overcome. The method is a good one, and the average job-shop foreman is no stranger to it, but suppose the discrepancy had been a matter of feet instead of inches?

The shop with which the writer is connected possesses the largest planer in London, yet many jobs come our way—such as the bases for motors and generators, soleplates for warming-rolls and calenders, etc.—that are far beyond its capacity in the matter of width. Our way to handle such jobs is to remove the "off" housing entirely and rig up a jury one. In the case cited by Mr. A'Hearn, where a cut was required down one side only, no jury housing would have been needed to handle that particular job.

We have an auxiliary tool-box and slide so arranged that it can be mounted on brackets that are fixed to the side of the planer bed, and with this accessory we are able to machine many parts that require planing only upon or near the edge of the casting.

Again, should a job be too high to pass beneath the cross-rail, we reach it with an extension tool-bar, held in the clapper-box, the latter being clamped so that it cannot lift on the forward stroke. For very long work we have a longer extension tool-bar that is supported at the outer end in a sleeve which is free to travel across the width of the planer in a slide attached to the planer table beyond the work. A device is provided for lifting the tool off the work on the return stroke.

We have attachments for concave and convex planing to any radius, also a master-cam device by which irregular surfaces may be planed. A planer with common sense attachments should be in every jobbing shop, and it is well for the proprietor to remember that a planer in its simple form as advertised by its builders does not represent half the actual value of the tool in the matter of capacity and versatility, if he but possess the ingenuity to devise ways and means to handle jobs that are out of the ordinary.

The writer is a strong advocate of the American open-side planer and also of the Richards side planer. If he were so fortunate as to be able to equip a shop of his own, these tools would be among the first to be specified.

The Macbine Repairman

By George Walter
Millholland Machine Co., Indianapolis, Ind.

IT HAS been declared by some noted authors on maintenance work that the machine repairman "must know the construction of almost every machine ever invented." If this statement were true genuine machine repairmen would be few and far between and of a certainty they would all be in their dotage. From experience I have found the most efficient machine repairman to be the one who rather than foolishly attempt to master the detailed construction of every individual make of machine, puts forth an effort to master the general principles of modern construction and handles the detail as he comes in contact with it on the job.

In dismantling an engine lathe or a milling machine the latter type of machine repairman knows he will find either one of two types of spindles: The one with the split taper bearings, with the thrust taken up at one end of the spindle; or one with straight bearings and the thrust taken up by washers at either end. The thrust washers themselves tell him the type of spindle he is working on. Their size and shape have been governed by the designing engineer and are none of his concern so long as he knows their purpose and how they are to be removed. As a rule the comparative size of these washers will tell him in which direction the bearing is tapered. The machine surfaces tell him how they are to be replaced.

I have found the following code to be of use to the machine repairman who may be expected to dismantle and repair almost any kind of machine at any time and under any conditions:

Use force as the last resort in dismantling a machine. Parts are placed in position and secured by locknuts, keys and collars. In many cases a series of such devices may have been employed on one single part and each must be cared for before the part can be removed. Don't stop at one setcrew when there may be half a dozen. To use the babbit block or sledge because "it sticks" must invariably result in broken castings, sprung shafts, stripped threads or battered keyways. Remove all retainers and then apply a strong steady force. If the part has not moved after what is apparently enough pressure has been exerted, take another look; some hidden corner may contain an unexpected setscrew.

When not thoroughly familiar with the type of machine in hand, center mark every part immediately upon removal. Care should be taken to place the mark in a place where the part will not be injured. Mark it so its position may be known precisely when re-assembling. This practice also serves as a check and prevents "spare parts" after the job has been "completed."

Don't batter. Use the babbit block or a piece of wood. Battered threads may be filed so as to make the nut fit but the strength of the thread must inevitably be weakened. The same applies to keyways; they may fit, but never properly, once they are battered.

Gasoline is cheaper to the employer than grit among working parts. If parts are thoroughly cleaned before being replaced unexpected flaws may be found.

Cover delicate parts with a cloth when chipping or drilling above them, then clean them. A shaving may have been clinging to the under side of the cloth. It is better to take a part to the drilling machine than to use a cloth over a gear box because the motor drill saves time.

Time will be saved by carefully studying a machine to be repaired before touching a wrench to it. If the exact trouble be ascertained first the repairman knows just how to get at it. Otherwise he must work at dismantling until he comes to the trouble. The average machine repairman rightly hesitates to remove parts which are in perfect working order.

If in doubt as to how to repair a part admit it and send it out. To do so is quicker, safer and cheaper. No matter how good a repairman is he is bound to strike a puzzler now and then.

When re-assembling, make every adjustment carefully. Do it as quickly as possible but do not let the saving of time interfere with thoroughness. Make a test run before pronouncing the machine O.K. if any great amount of work has been done on it.

Allow end play on shafting wherever possible.

Draw thrust bearings up no tighter than absolutely necessary.

Inspect all gears for bad teeth and shavings.

Inspect all oil rings carefully.

Use plenty of shims and tighten nuts "tight."

Always use two wrenches when tightening locknuts. Don't trust the lower nut not to move. It will often turn unnoticed.

Watch bearings closely for heating during the test run.

Never forget to replace the guards.

Experience shows the real machine repairman just how this or that should be and he generally finds it so. The fundamental principles of modern construction after having been divided into a few main classes are just about the same. The difference in shape and size should cause him no worry.

Forget about "almost every kind of machine ever invented." Learn the way the thing is usually done, then go ahead and do the job. Thinking brains are as essential to the first class machine repairman as hands are and he must not hesitate to use them when confronted with an unusual job.

Depreciation of a Lathe—Discussion

By L. L. Thwing

On page 576 Vol. 58 of the *American Machinist* C. J. Morrison in commenting on the residual value of a lathe ten years old, suggests that the sale value of an article is co-extensive with its useful value to its owner. The only time that the sale or salvage value of a machine equals its useful value to its owner, is when said owner has no use for it, and has crossed it off his books as an active producing unit. This may be illustrated by considerating a pair of shoes that has been worn long enough to be comfortable, but not long enough to be shabby. Will any owner arise and say that the value of such a pair of shoes to him is not much greater than what he could sell them for to the old clothes man?

Consider the old-fashioned undershot waterwheels mentioned by Harry Senior in his much appreciated defense of the old millwright. These waterwheels could not be sold for anything, but they *do* run a factory, and no one not familiar with the exact conditions at that factory can say that they are not worth what they would cost to replace, less depreciation, or the present day cost of a modern turbine to do the same work.

That there is a difference between sale value and useful or sound value is evidenced by the difference in sale price when a plant is sold as a "going business" as compared with the receipts by dispersal as the auctioneers now call it. You may say that there is a certain amount of "good will" included in the first sale and there is. And it is Mr. Forbes' good will toward his ten-year-old lathe that makes it worth more than its sale value, to say nothing of its scrap value.

Six Ways to Use Portable Tools

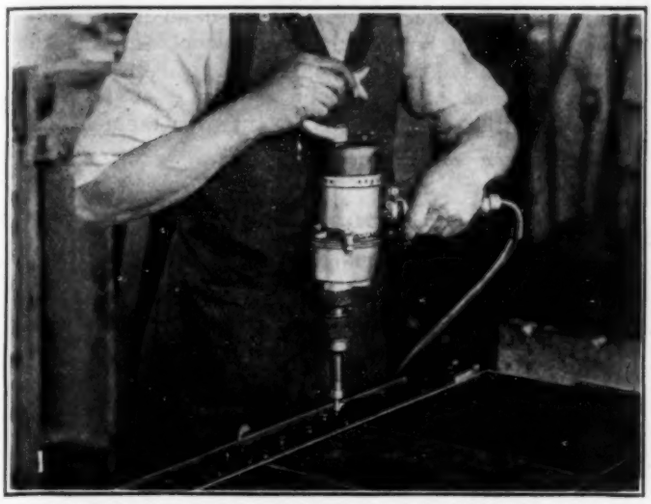

Fig. 1—Thor electric drill, driving ¾-in. flat-head wood screws at the rate of 20 per min. in assembling the feeder beds of Kelley presses at the plant of the American Type Founders Co., Jersey City, N. J.

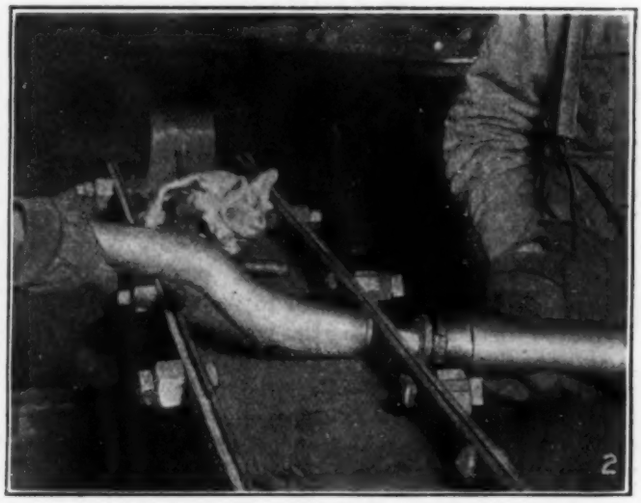

Fig. 2—Boyer long-stroke air hammer, $1\frac{1}{16}$ x 8 in., riveting channels and plates into heavy box girders at Columbia Machine Works, Brooklyn, N. Y. Shows temporary bolting and holder-on in place.

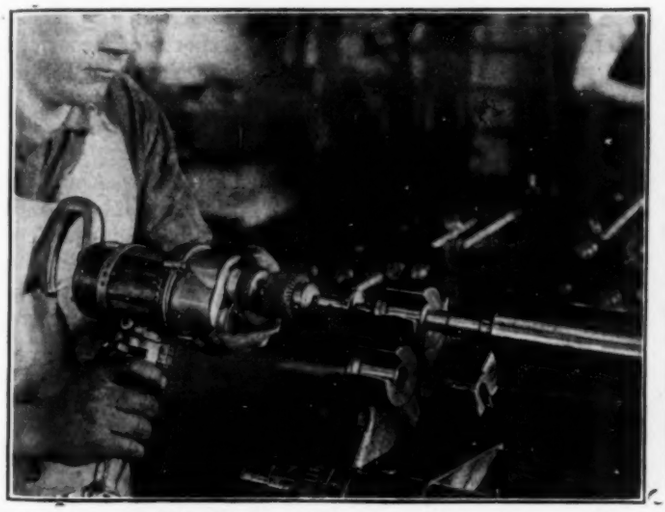

Fig. 3—Thor electric drill, used for running-in bearings of inking rollers on Kelley presses. The high speed makes it advantageous for this work. American Type Founders Co., Jersey City, N. J.

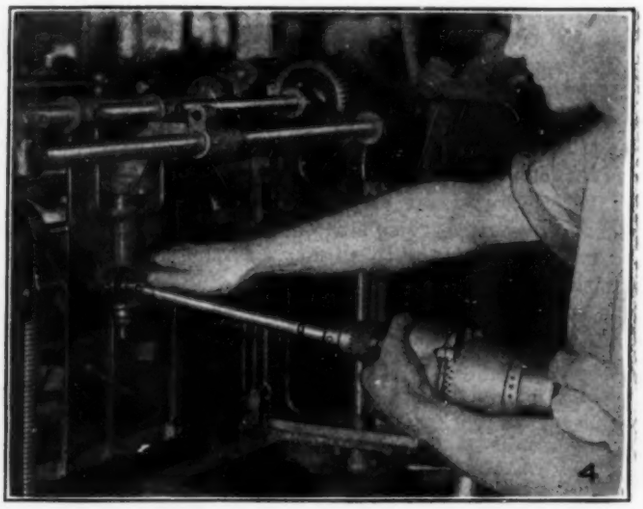

Fig. 4—Thor electric drill, driving special tool for milling radius on Kelley press feeder. Fixture swings on the shaft to give proper radius. American Type Founders Co., Jersey City, N. J.

Fig. 5—Thor pneumatic hammer, chipping bronze pump-impeller at Worthington Pump & Machinery Corp., Harrison, N. J. Its use saves much time and secures greater accuracy than can be attained by hand chipping.

Fig. 6—Cleveland pneumatic drill, driving grinding wheel for finishing surface of impeller. Saves much filing and scraping and leaves surface in better condition. Worthington Pump & Machinery Corp., Harrison, N. J.

The Opportunity School in Denver

THERE is a unique educational institution in Denver, Colo., known as the Opportunity School where anyone in the city can receive instruction in almost any line of work. Girls and boys within the school age must have special reason, but men and women, without regard to age, color, nationality, residence or previous condition of employment, here have the opportunity of increasing their knowledge in different lines of work, or of learning the rudiments of some other trade or profession.

If out of work they can go to daytime classes or if employed there are evening classes under skilled instructors. For the men the instruction includes machine shop work, woodwork, masonry, plumbing, cobbling, telegraphy, oxy-acetylene and arc welding, automobile motor repairing, tire vulcanizing and rebuilding, storage battery work, ignition systems, drafting and other trades.

There is none of that bane of vocational training known as "exercises." Real, honest-to-goodness work is provided either by manufacturers or other citizens. In the case of tire repairs any citizen can bring his old tires to be patched, vulcanized or retreaded. When these fail to give enough work old tires are secured from other sources. The same holds true in automobile repairing. Any citizen may bring his car and have it overhauled by the students all of whom are under skilled instructors. It is not to be supposed that every car receives the very best of skilled workmanship, but it is safe to bet that it fares as well as it does in the average garage or even service station, for there is no incentive to rush the work or to slight it for lack of time. Any citizen who desires may come in at any time and receive instruction when classes are not too full but students may not bring in their own cars to be repaired so that there is no favoritism in the care given any piece of work. The class is primarily for those going into the trade or as work related to their trade.

Machine Shop Makes Useful Things

The equipment is good but not so good, that the man or boy will be at sea when he goes to work in the average shop. The machine shop makes a large amount of the equipment used by the other vocational schools in the city. In this way the student, be he boy or man, has the incentive and the satisfaction of making something which is really useful and not merely an "exercise" to be thrown away after it is made.

Girls and women may get instruction in many lines such as shorthand, typewriting, dictaphone operation, multigraphing, bookkeeping, accounting, dressmaking, millinery, cooking, manicuring, hair dressing and all the latest in the work of the beauty parlor. In this way they may become self supporting or may help out slender incomes in a substantial manner.

Other special features are classes for older people who do not read or write English, English for foreigners, citizenship classes and an employment bureau which places students in paying positions. In order to make it easy for workers to come directly to school from the shop, a bowl of good soup is served without expense, which saves considerable time and prevents the necessity of going home until after school. The school is open from 8 a.m. to 9.15 p.m. to people of all ages. There are no entrance requirements. Anyone can enter at any time and can devote as much time as his circumstances permit.

This school was started seven years ago by Miss Emily Griffith under whose guiding hand it has grown from very small beginnings to a school of over 3,000 people and it is still growing. Miss Griffith has the hearty support of the business men of Denver who appreciate that this work is getting for them a better and more efficient class of employees.

Exports of Labor-Saving Equipment

Typical of American exports of machinery and equipment especially fitted for the newer countries are the sales abroad of agricultural implements and of construction, well-drilling, lumbering and mining machinery, states E. M. Miller, statistician of the National Bank of Commerce, New York, in *Commerce Monthly*. The fitness of American machinery for conditions in new countries is quite as great in manufacturing industries. Development in these countries is repeating the history of the growth of manufactures here. Aside from a general labor shortage, there is a special dearth of skilled operatives. Machinery as nearly automatic as possible is therefore necessary, and the high costs of production in new countries make it obligatory to secure the maximum output per worker. Exports of American shoe machinery are illustrative of this class. It is well adapted for the development of shoe manufacturing in such countries as Argentina, Brazil and Canada, but Europe has also been a heavy buyer.

Certain criticisms interpreted as adverse to American manufacturers of machinery are hardly capable of such interpretation. Thus a common charge is that American machinery in some important lines is not so durable as is that of European manufacture. The United States is not a maker of cheap and fragile machines. The tremendous output per man of its industry and its amazing history as a successful manufacturing nation alone should be sufficient to demonstrate the unsoundness of this criticism.

The American theory of industry differs in essential ways from that of Europe. The American manufacturer demands durability, but he does not desire his equipment to last forever. He knows that there will be mechanical improvements made, so great that he cannot afford indefinitely to use machinery of a lower productivity than that possessed by a competitor whose plant is newer. American machinery is built to earn its own replacement costs and to make a profit, but American industry is not disposed to accept the dictum that perfection has been attained in any line. Because of this attitude toward the question of equipment, American machinery manufacturers have considered such points as lightness and ease of operation equally as important as durability. Important factors in the sale of American machinery abroad are the development of the principle of interchangeable parts and of the American service systems. These methods are the direct outgrowth of conditions in the United States. Large scale production tends inevitably to standardization and ultimately to a high degree of interchangeability. The profitable development of service systems would not be possible except in a very wide market. This the United States has furnished. The development of service systems has been further stimulated by the fact that in this country the supply of skilled mechanics has always been limited in relation to demand.

Industrial Cost Accounting For Executives

By PAUL M. ATKINS

The twelfth article—Classification of expenses—The expense manual and its operation — Division into manufacturing, selling and administration functions

THE SATISFACTORY handling of expenses is probably the most perplexing problem to be found in all industrial cost accounting, at least on the theoretical side. If the theory of underlying expenses is really understood, however, it is usually possible to work out a usable method, although sometimes practice will depart some distance from theory on the way. In the next few articles we shall turn our attention to expenses and endeavor to obtain such a grasp of the question that it will be possible to grapple successfully with the problem as it presents itself in our own business.

The very first step in dealing with expenses is to get them properly classified for as long as they remain a heterogeneous mass it is impossible to study them, record them or distribute them. It is right at this point also that the first mistake is made in handling the problem. In general, there are two different ways in which expenses may be classified. One of them is according to the nature of the expense—supervision, supplies and maintenance. The other is according to the cause of the expense, which means really by departments, for it is the operation of the several departments which gives rise to the expense.

The Two Expense Classifications

It is according to the first of these conditions that most expense classifications are worked. It is for such a reason that the distribution of the expenses to the product is so difficult for there is little or no relation between the nature of the expense and the product on which it is to be loaded. The other basis is the more rational of the two for it is logical that the cost of a service—the cost of operation of the department—should be charged against the product which receives the benefit of that service.

If expenses are simply to be classified according to departments, however, the result will be such a miscellaneous collection of charges that it will require a very careful analysis in order to obtain any real idea of their nature. It must not be forgotten that while the expense accounts are used to prepare the burden charges for the product, they also have another function to perform, that is, to supply information to the management which will aid it in the control of the business. If expenses are running too high, it is rather important for the management to be able to find out not only which departments are responsible for the excess but also to what kinds of expenses within these departments the inflation is due. If the cause is an excessive consumption of supplies, the remedy will be quite different from what it would be if idle time were the reason.

In general, then it is wise to classify the expenses first according to the nature of the expense. The expenses may be so gathered together as to facilitate their distribution and final allocation to the product. At the same time the full benefit of expense statistics as a control device in the hands of the executive may be obtained. If, for any reason, the total of any class of expense is desired, it is an easy matter to collect the amount from among the departmental expense accounts by means of an adding machine.

Operation of an Expense Manual

When expenses have been classified the next step is to prepare an expense manual in which should be recorded in detail a description of the charges to the several expense accounts. It is very easy to forget the exact divisions between the various accounts in the classification even though it should be relatively easy to remember the classification itself if it has been properly symbolized. When such a manual has been prepared, reference to it is easy and so it should seldom be really difficult to decide to which expense account a particular item should be charged. It must be remembered that the statistics which may be prepared from the expense accounts are of little value for purposes of comparison if items are charged to one account at one time and to another at another time.

The accompanying plates have been worked out in the form of sheets of such an expense manual, though only one departmental expense account has been worked out in detail to illustrate typical office and factory departments. A complete expense manual is, of course, very much larger than the sections shown here, but a capable cost accountant should be able to work out one for his own concern using what is given here as a guide.

One of the first things to strike the eye on looking over these plates is the detail in which the expense classification is given. There are several reasons for these details. In the first place it was desired to show the detail of such a classification for a moderately large-sized concern in order that the necessity of an expense manual may better be realized. It is not at all essential, however, that the subdivisions be carried to such an extent as they have been here. It is quite pos-

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sible for a smaller concern to combine accounts within departments and also to unite several departments to form one in other cases and so greatly reduce the amount of detail shown. It is usually much easier to contract such a classification than it is to expand it and so it has been outlined here on a relatively large scale.

It must also be remembered that it is much easier to add figures than it is to divide them. Just so also it is easier to combine amounts recorded in detailed expense accounts to give totals than it is to analyze an account into the elements which compose it. It is a good rule to follow that in case of doubt as to whether or not to have a detailed account, to put it in, for it is easier to combine accounts later on than to segregate them. There are few things which are more wearisome and unsatisfactory both to those who do this work and to those who use the results than to analyze the recorded figures in an expense account.

Perhaps the second thing to attract attention about these plates is the symbolization of the accounts. It should be remembered that in the article dealing with business functions it was pointed out that the mnemonic method of symbolization had the great advantage of expansibility in addition to its mnemonic character. These plates illustrate the point very well, especially Plate MA where we have thirteen co-ordinate subdivisions, something which would be quite impossible under a numerical system of symbolization.

Adding Departments or Accounts

The present arrangement shows very clearly also, the open symbols so that if later on it seems desirable to add other departments or accounts, it may be done with the minimum of inconvenience. If the manual is prepared in loose-leaf form and if the section dealing with a single department always begins a page, the insertion of a section into the manual offers no difficulties whatever. It must not be forgotten, however, that, for a time at least, the basis of comparison of the actual expense figures is destroyed.

For those who read carefully the article referred to in the paragraph above, the fourth one in the series, the basis of the classification is quite clear. To refresh the minds of those who may have forgotten or who did not read that article, it is briefly summarized as follows: The expenses of a business having been defined as the costs of carrying on the various functions or activities of the business, it is necessary to analyze a business into its various functions. For a manufacturing business these functions may be grouped under three main heads—those functions which are involved practically entirely in the production of the finished goods and are called manufacturing functions, those involved in the sale of those goods which are called selling functions, and those involved in the co-ordination, supervision of and service to both groups of functions or functions within this last group which are called administration functions.

The first group is subdivided into two classes which are indicated by the names auxiliary and direct manufacturing functions, depending on whether they have a direct part or not in changing the form and condition (though not position) of the materials which go into the finished product. These classes are then divided into departments, as has been indicated. The second group, the selling function, is divided directly into departments, while the last group is segregated into several classes before being broken up into departments. For a further discussion of the whole problem and for the reasons underlying the grouping in this fashion the reader is referred to the article in the series mentioned above.

The various accounts are to be discussed at some length in the succeeding articles so space will be taken here only to outline briefly some of the accounts whose meaning may at first appear obscure. Fixed charges, for example, is a term used to indicate an account for each department to which the depreciation on all fixed assets used by the department is to be charged. The same account also serves to contain the debits for property taxes and insurance. Since these items are fixed in amount, hence the monthly charge is always the same and nothing is gained by having separate accounts for these items. If the management wishes to know the details they can be obtained at any time from a schedule sheet which is described in detail in a later article.

The Various Other Accounts

Employee liability insurance has an account for itself for each department since the amount of the premium varies from month to month with the amount of the payroll.

The reclamation of errors account which appears in the classification is an account which is not often found. To it should be charged all losses due to errors and mistakes made by members of the department. It is based on the fundamentally sound principle that each department should bear the burden of the loss which it causes. The great difficulty in actual practice is to find the ultimate cause of certain losses. Sometimes an error will not be discovered till long after it has been made and hence its trail may be too obscure to be traced. Whenever practicable, however, the account is excellent to have for it helps to fix responsibility.

Under the head of wages and salaries will be found a retainer account. The account is also an unusual but very valuable record for it shows the cost of idle-man-time in the factory. It is one of the most important detail accounts from the point of view of executive control and one of the few accounts that it is often desirable to analyze in order to get at the elements. It is a very valuable indicator of the efficiency of control of manufacturing operations, for whether business is slack or rushing, work should be so planned, scheduled and dispatched as to keep all workers on the payroll occupied.

The Non-Assignable Expenses

The non-assignable expenses which are mentioned in several places are those expenses which are chargeable to a certain group of functions but because of the nature of the expense are not assignable to any department within the group. They are usually few in number and small in amount and while often they present knotty theoretical problems are seldom troublesome in actual practice.

The decision whether or not to open a certain account will depend on a number of factors. If the expense is relatively fixed in amount it may often be grouped with others for that very reason. Its slight fluctuations do not have any particular significance to the business. The expenses which vary rapidly are the ones which most need separate accounts so that they can be carefully watched.

BASE PLATE—AN EXPENSE CLASSIFICATION

A—Administration Departments Expenses.
(B to L omitted.)
M—Manufacturing Departments Expenses (for details see Plate M.)
N—Non-Operating Expenses.
P—
R—
S—Selling Departments Expenses
(T to Z omitted.)

PLATE M—MANUFACTURING DEPARTMENTS EXPENSES

MA—Auxiliary Manufacturing Departments Expenses (for details see Plate MA.)
MB—
MC—
MD—Direct Manufacturing Departments Expenses (for details see Plate MD.)
(ME to MM omitted.)
MN—Non-Assignable Manufacturing Expenses (for details see Plate MN.)
(MP to MZ omitted.)

PLATE MA—AUXILIARY MANUFACTURING DEPARTMENTS EXPENSES

MAA—
MAB—Buying or Purchasing Department Expenses.
MAC—Cost Department Expenses.
MAD—Manufacturing Standards Department Expenses.
MAE—
MAF—Finished Stock and Shipping Department Expenses.
MAG—
MAH—Heat, Light and Power Department Expenses.
MAJ—Inspection Department Expenses.
MAK—
MAL—
MAM—Maintenance Department Expenses.
MAN—Pattern Shop Expenses.
MAP—Planning Department Expenses.
MAR—Receiving Department Expenses.
MAS—Stores Department Expenses.
MAT—Tool Manufacturing Department Expenses.
MAV—Internal Transportation Department Expenses.
(MAW to MAZ omitted.)

PLATE MD—DIRECT MANUFACTURING DEPARTMENTS EXPENSES

MDA—Assembly Department Expenses.
(MDB to MDE omitted.)
MDF—Foundry Department Expenses.
(MDG to MDL omitted.)
MDM—Machine Shop Expenses.
(MDN to MDZ omitted.)

PLATE MN—NON-ASSIGNABLE MANUFACTURING EXPENSES

MNA—
MNB—Non-Assignable Building Expenses.
MNC—
MND—Defective Materials Expense.
MNE—
MNF—
MNG—Grounds Expenses.
(MNH to MNV omitted.)
MNW—Watchman Expense.
(MNX to MNZ omitted.)

PLATE MDM—MACHINE SHOP EXPENSES

(MDMA to MDME omitted.)
MDMF—Fixed Charges Account—All fixed charges chargeable to this department including depreciation, property insurance and property taxes on the part of the building occupied by this department and on all equipment used thereby including furniture and fixtures and machinery.
MDMG—
MDMH—Heat, Light and Power Account—Cost of all heat, light and power used by this department and purchased from outside suppliers.
MDMJ—Insurance, Employee Liability, Account—Cost of all premiums of liability insurance carried on employees who work in this department.
MDMK—
MDML—
MDMM—Maintenance Account—for subdivision see Plate MDMM.
MDMN—
MDMP—
MDMR—Reclamation of Errors Account—Costs of reclaiming, repairing or replacing losses due to mistakes made by this department, or the amount of such losses if they are not reclaimed.
MDMS—Supplies Account—Cost of all supplies used by this department including printed forms, stationary, oil, waste, emery cloth, emery dust, cooling fluids, small tools not carried in the tool inventory such as: files, hammers, wrenches, screw drivers, cold chisels, and materials used on orders too small in value or too difficult of apportionment to be charged to the orders.
MDMT—
MDMV—
MDMW—Wages and Salaries Account—for subdivisions see Plate MDMW.
MDMX—
MDMY—
MDMZ—Miscellaneous Expense Account—All expenses chargeable to this department which are not assignable to some other expense account of this department.

PLATE MDMM—MACHINE SHOP MAINTENANCE ACCOUNTS

MDMMA—
MDMMB—Buildings, Maintenance of, Account—All costs of repairing and maintaining that part of the building occupied by this department including floors, walls, windows, ceilings and doors.
(MDMMC to MDMME omitted.)
MDMMF—Furniture and Fixtures, Maintenance of, Account—All costs of repairing and maintaining the furniture and fixtures used by this department including lighting, heating, ventilating and plumbing fixtures, chairs, tools, desks, benches, tables and attachments.
(MDMMG to MDMML omitted.)
MDMMM—Machinery, Maintenance of, Account—Cost of repairing and maintaining all machinery used by this department including all motors, shafting, lathes, milling machines, planers, shapers, drills, grinders, and all other power operated machines, transportation machinery located permanently in the department, such as overhead and monorail cranes, hoists and auxiliary machinery of all kinds such as pneumatic hammers.
(MDMMD to MDMMS omitted.)
MDMMT—Tools, Maintenance of, Account—Cost of repairing and maintaining all tools used by this department, both hand and machine operated tools, including lathe tools, millers, large drills and broaching tools.
(MDMMV to MDMMZ omitted.)

PLATE MDMW—MACHINE SHOP WAGES AND SALARIES ACCOUNT

(MDMWA to MDMWH omitted.)
MDMWJ—Inspectors Account—Wages of all inspectors whose time is given to inspecting work done in this department.
MDMWK—
MDMWL—
MDMWM—Move-men Account—Wages of all men whose time is given to moving material within or from this department.
MDMWN—Instructors Account—Wages of all instructors whose time is given to teaching workers in this department.
MDMWP—Planning and Dispatch Clerks Account—Wages of all clerks located in this department whose time is given to planning or dispatching work through this department.
MDMWR—Retainers Account—All wages paid workers to retain them at the factory when they are temporarily not employed through no fault of their own, as because of lack of material, breakdown of machinery or stoppage of power.
MDMWS—Supervision Account—Wages and salaries of the foremen and his immediate assistants whose time is given to supervising the work of this department.
(MDMWT to MDMWT omitted.)

Testing Bearing Metals and Lubricants

By Major F. Johnstone-Taylor

Up to a comparatively recent date, the question of lubrication was subject to little or no scientific investigation. Bearings were designed so that the pressure per square inch of bearing surface did not exceed a certain limit, oil was applied thereto by simple methods and, provided that what was thought to be a suitable bearing metal was used, running conditions were left to take care of themselves. With ordinary speeds and no great weight on the journals, such bearings, lined usually with some form of babbitt, gave fairly satisfactory results. As they were of a comparatively simple nature, they were more or less easy to replace if they failed through overheating or other cause.

The advent, however, of high speeds and continually higher speeds together with the necessity of permitting increased bearing pressures, soon made it evident that something more than mere wick feed was necessary for supplying oil. The general design of bearings subject to high speeds and heavy pressures had to undergo considerable revision. The actual qualities of oil supplied for different purposes had to be determined with greater precision than hitherto if they were to really suit the wide variety of conditions called for. In other words, merely to run up a bearing with any handy anti-friction metal and then to oil it, is a procedure which has now a very limited application.

During the last few years extensive laboratory experiments have been made in England to arrive at something like a definite conclusion on the whole question of bearings. The apparatus used and the results obtained afford information valuable to the designer and experimental engineer.

Measurement of Oil Film

The measurement of oil film thickness and the frictional resistance formed the basis of a series of experiments at the Manchester School of Technology. The apparatus employed was specially designed for the purpose, and the measurements of the oil film thickness and the shear or frictional resistance that have been obtained from it up to the present are of interest.

The apparatus is shown in Fig. 1. It consists essentially of a cast-iron casing *A* provided with two gunmetal bearings in which runs the mild steel journal *B* with speeds of from 2,500 to 6,000 r.p.m. obtainable by means of a belt drive from a small electric motor. The central portion of the journal, 2.5 in. in diameter, is embraced by two opposing symmetrically shaped white metalled bearings *CC*, each 4 in. long and carefully scraped to fit the journal as exactly as possible over an arc of contact of 90 deg. These bearings are secured to two arms *DD* which are held together by means of two independent links provided with knife-edge attachments. The lower pair of these knife-edges *EE* are maintained at a fixed distance apart. The upper pair *FF* are relatively movable and are controlled by the calibrated spring *G* which can be compressed by a wing nut, so that any desired pressure can be exerted by the bearings on the journal, with the lower knife-edges acting as a fulcrum.

The weight of the arms and their various fittings is counterbalanced by means of the four-rod suspension shown in Fig. 1 to relieve the journal of all vertical pressure. The position of these points of suspension on the arms are chosen so as to maintain just the sufficient rotational stability about the journal axis to keep the arms in their normal vertical position without interfering with the possible displacements of the arms relative to one another. The casing *A* is filled with oil to a level of about 3 in. above the top of the journal. A copper water circulation coil, not shown, is inserted

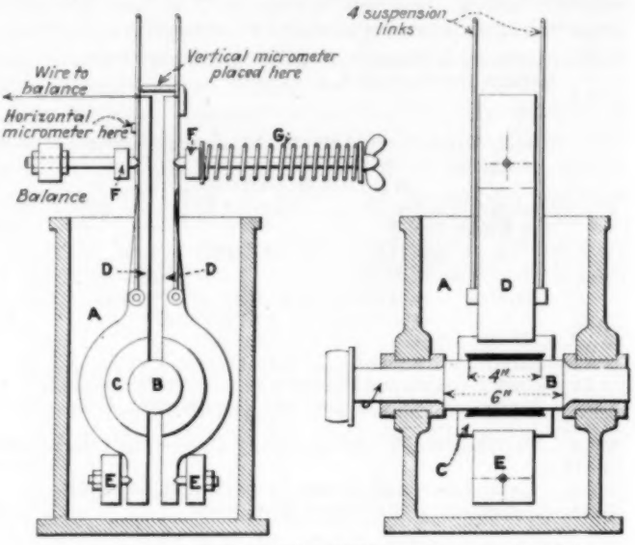


FIG. 1—APPARATUS FOR MEASURING OIL FILM THICKNESS AND SHEAR

in the lower half of the casing to facilitate temperature regulation.

The operation of the apparatus depends on the fact that with a rotation of the journal a wedge-shaped film of oil will be introduced between each brass and the journal. The thickness of this film will depend on the pressure, the rubbing speed and the viscosity of the oil. The formation of this film is necessarily accompanied by small displacements of the arms holding the brasses. The only restraint to the relative motion is that supplied by the spring. To measure these relative displacements, two micrometers, one vertical and one horizontal, are fitted at the end of the arms. With the measurements thus obtained, the actual displacement of the

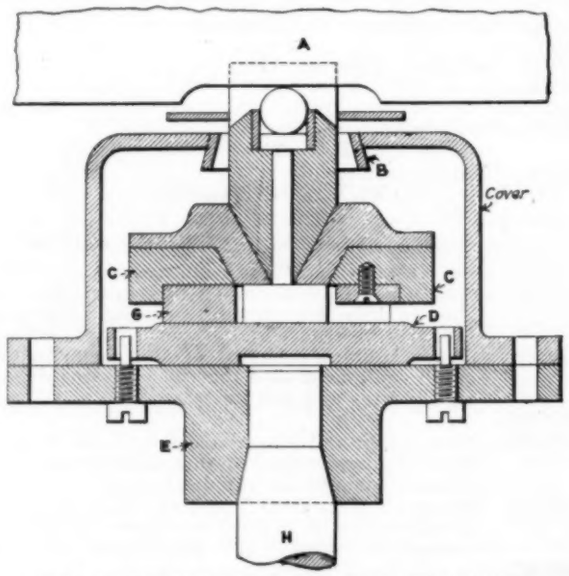


FIG. 2—APPARATUS USED IN EXPERIMENT WITH MICHELL PADS

brasses relative to the journal and the thickness of the film can be calculated. The shear or frictional resistance is determined by the measurement of the horizontal force required at the end of the arms to counteract the turning effect about the journal axis and maintain the arms in their normal vertical position.

The procedure adopted when taking observations is briefly as follows: The oil is brought to the required temperature by the rotation of the journal with the spring set for some convenient load and is maintained at this temperature by the regulated flow of cooling water through the coil until the whole apparatus has become correspondingly warmed up. The journal is then stopped and the spring is correctly adjusted to give the desired test load on the brasses. Initial zero readings are taken and the journal is restarted. Measurements are made for a series of gradually increased speeds, at the end of which the journal is stopped and the zero readings again taken as a check. From a complete set of results the following formulas were deduced:

$$\epsilon = 0.00986 \frac{\lambda 0.46\ v^{0.71}}{P^{0.75}} \text{ inches}$$

$$\rho = 0.0370\ \lambda^{0.42}\ v^{0.475}\ P^{0.375} \text{ lb. per square inch}$$

where λ is viscosity in degrees per square centimeter

v = Rubbing speed, ft. per second

P = Intensity of pressure on brasses in lb. per square inch.

The intensities of pressure and shear are reckoned on the full projected area of the journal, 10 sq.in. These formulas compare not unfavorably with the purely theoretical formulas:

$$\epsilon = c \left(\frac{\lambda v}{P}\right)^{0.5}$$

$$\rho = \kappa\ (\lambda P v)^{0.5}$$

The discrepancy affecting the indices is possibly attributable to the combined effect of lateral flow or side leakage and variations of viscosity along the arc of contact due to rise in temperature of the oil film. Both of these factors are neglected in the simple theoretical treatment. It is important to notice, however, that both the experimental and theoretical formulas are in agreement respecting the dependence of shear on load. This fact is in direct opposition to the usually accepted statement that shear is independent of pressure.

Experiment with Michell Pads

The investigation of lubrication problems is complicated by the number of factors involved. Each of these factors must be isolated, and its influence noted before reliable deductions can be made from experimental data. Not only must variations in speed and resistance be plotted against pressure, but the viscosity of the lubricant must be plotted against temperature and converted into oil film shear at these varying speeds and pressures, before experimental results can be directly compared with Osborne Reynold's theory of lubrication.

The tests under consideration were made with segmental pivoted blocks or pads of the Michell type. The apparatus used consisted of an electric motor of 1 hp. with a vertical spindle. The bottom end of the spindle was carried in a Michell thrust bearing, and the top of the spindle was provided with a flat disk supporting a similar bearing upon which the observations were made. The spindle of the motor is loaded by a weighted lever with a ball knife edge to nullify friction. Referring to Fig. 2, *A* is the loading lever, *B* an oil retaining ring in the cover. The retaining ring is shown at *C* and the revolving thrust plate at *D*. At *E* is the thrust collar and at *G* the pads. At *H* is shown the motor shaft.

The pads and collars are finished by precision grinding so that when the pads are slid dry on to the collar the suction is sufficient for the collar to be lifted by its adhesion to the pads. The leading edges of the pads are rounded to about $\frac{1}{16}$ in. radius. As a further precaution, the pull of the torque arm is measured in both directions and the difference taken as being the actual pull. The viscosity of the lubricant used was determined by means of a Michell viscometer.

In the case of pads pivoted at or near the theoretically correct position the results obtained experimentally are in close agreement with those calculated from pure theory. This is especially so if allowance is made for slight errors of observation in the experimental results and the approximations made in the theory. Tests were also made with centrally-pivoted pads but the results no longer agree with theory, and such pads are very much less efficient than those offset.

Experiments with Bearing Metals

The National Physical Laboratory of Great Britain has recently installed a simple apparatus for testing bushes. This machine is illustrated diagrammatically in Fig. 3. The bush under test is *A*, the journal is *B*, a spherical bush holder *C*. A pointer *D* is the indicator on a suitable scale; *E* is the loading beam; *FF* the loading weights and *GG* the weights for balancing friction.

In the machine shown in Fig. 3, arrangements are made for working at high pressures and for supplying an excess of oil to the bush under test. The oil is supplied from a displacement cylinder which is separately driven by an electric motor. In this way the flow of oil can be regulated at a speed independent

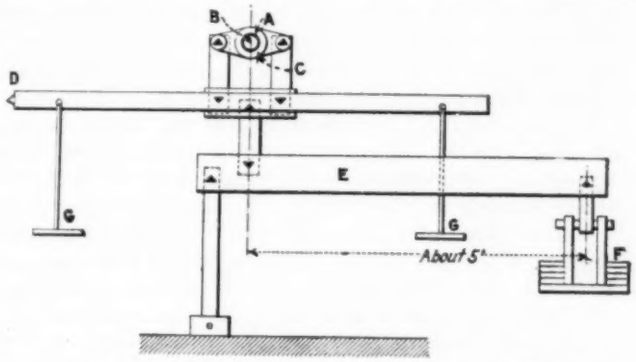


FIG. 3—APPARATUS FOR TESTING BUSHES

of that of the friction machine, and the bearing can be flooded before starting the motion of the journal.

In the machine, a bush in a suitable holder is run upon a journal turned on the end of the shaft. The load is applied to the frame by means of a lever and a parallelogram of links, so that a rotation of the holder about the shaft will not displace the line of pull from the axis of the shaft. By this means, very high loads, up to 10 tons, can be applied. Some error, however, might be introduced if the knife edges did not always seat themselves in the same place, and if the bush became displaced radially from the center of the shaft. Tests can be carried out in both directions of rotation, and if the radial shaft is constant, its effect is elimi-

nated in taking the mean torque in the two directions.

In a dead load test on another machine, the bearing surface consisted of four rings, each ½ in. wide. The shaft diameter was 2 in. so that the projected area was 4 sq.in. In the series of tests on the lever-loaded machine shown in Fig. 3 the axial length of metal in the bush was 1.82 in. and the diameter 2 in. so that the projected area was 3.64 square inches.

In the lever-loaded machine, the oil is supplied to the underside of the bearing by means of a displacement ram and no oil grooves are necessary. It is to be noted that the underside in each case is the surface free from pressure and the film of oil is carried round to the pressure side by the shaft or journal. The bore of the bush is 0.004 in. larger than the diameter of the shaft.

From tests made on white bearing metal, it appears that for loading up to 250 lb. per square inch without force-feed lubrication, this metal gives as good results as may be expected from such a bearing, but with heavier loads, seizing may occur. Suitable metal may become very hot without running out, for at the end of the first series of tests the temperature estimated from the coloring of the shaft must have been locally as high as 700 deg. F. Under forced lubrication, a proprietory article known as Friary metal has given extraordinarily good results as regards friction. Even with a load of over 1,000 lb. per square inch, this metal showed no signs of wear or flow, although the temperature rose to 200 deg. F. The oil used in the tests was a moderately heavy motor engine oil. The above results refer to bearings in which the metal is run in from a ladle. It is possible that die-cast bearings would give still higher safe running loads.

The Disease Called Drafting—Discussion

BY G. W. NUSBAUM

On page 960, Vol. 57, of the *American Machinist*, Elam Whitney discusses under the above title Entropy's reference to drafting as a disease and points out some very pertinent facts. However, there is a phase of the trouble which has not yet been brought to light in print.

The point raised by the writer of the above discussion, i.e., that the compensation of designers is too often inadequate as compared with other lines of endeavor which require no technical education and very little inventive genius, is certainly true. Under the present conditions the pay of the real designer or engineer and that of a draftsman are practically the same, the former suffering from a title which he has not been able to outgrow, due to conditions over which he has no control.

Webster defines a draftsman as "one who draws plans or sketches of machinery, structures and places; also, more generally, one who makes drawings of any kind." It will be noted that in this definition no reference is made to designing, nor to the engineering qualifications necessary to do so. In other words, the term implies that the activities of a draftsman are purely those of an artisan. With this definition in mind, and it is undoubtedly the generally accepted one, it is evident that most manufacturing concerns must have many employees who do more than draw plans. Before the plan is drawn it must be conceived and proportioned to satisfactorily withstand the stresses to which the final machine or structure will be subjected when performing its required functions. These employees are usually members of the drafting room force, having titles which do not convey any idea as to their actual duties and accomplishments.

As long as a man works in a so-called "drafting room" he is called a draftsman, regardless of the nature of his duties. If he is concerned purely with designs and never produces a drawing, he is called a draftsman; when he reaches the top of the ladder he is given the designation of "chief," but the term "draftsman" still clings to him. The title is like a leech and cannot be shaken off without leaving the drafting room for other employment. To the writer's mind, it is just as erroneous to call men draftsmen simply because they are working in drafting rooms, although they are doing engineering work, as it is to call an engine driver an engineer.

About a year ago the writer, as president of the American Society of Marine Draftsmen, spoke to a national convention of that body on the subject of the term "draftsmen" being a misnomer. This society has since changed its name to the American Society of Marine Designers. This change by a large body of men actually employed in drafting rooms shows their recognition of the misapplication of the term "draftsmen."

If the drafting rooms are to continue to draw men who are capable of carrying major designs to completion, there should be more incentive held out to them than the prospect of having the perpetual title of "draftsman."

Meeting the Race Problem in Industry

BY A. K. LEWIS
Director Personal Service Division,
The American Rolling Mill Co.

Believing that the right kind of colored people are attracted, as are whites, by a pleasant environment; that they appreciate a home with a garden, a bath, electric lights, cistern water and such improvements, houses of this character were built and sold on easy terms to colored people. This development extends in several blocks on both sides of two fine streets and every home was sold to a colored workman.

Realizing that wherever two races work in close proximity, there is likely to be friction, steps were taken to prevent this as far as possible. These colored people, through prominent speakers of their own race, and responsible white men, were told that the only way they can live happily with white people is by doing their work so well and by being such good neighbors and citizens that the white man will be glad to help them. They were told that the black man and the white man are different; that the colored man is no more an inferior white man than is the white man a superior negro. Both must together travel along the highway of Progress, and the colored man, of necessity, occupies the rear of the procession because he has nothing in his historical background that the white man wants—neither language, nor laws, nor religion. Neither color, nor art, nor traditions. To keep pace with the white man, the colored man needs must share in the white man's priceless possessions. And the colored man must retain the white man's good will, for in any conflict the colored man must necessarily lose.

Excerpts from a speech delivered at the National Conference of Business Paper Editors at Middletown, Ohio.

The Advantages of Unilateral Tolerances

By E. C. PECK
General Superintendent, Cleveland Twist Drill Company

The economy of being able to use standard gages—Necessity of an unvarying zero point—Comparison with the bilateral system

IT SEEMS best in the discussion of this subject to approach it in an elementary way and by this means ascertain the worth of the foundation on which it stands. If this foundation is sound, the structure practical, and its use of economical value, it is bound to commend itself to those whose interest and vocation are vitally affected.

Why do we need any system of tolerances? What part do tolerances play in the commerce and manufacture of the world?

The most important or primary purpose of tolerances is for interchangeable manufacture. No discussion of any tolerance system should have recognized weight which does not have the attainment of interchangeability as its ultimate goal.

THE ADVANTAGES of Unilateral Tolerances and their effect on economical manufacture are of such vital importance that the system should be thoroughly understood by all concerned, by all having to do with economical production. We, therefore, urge a careful study of the comparative simplicity of the Unilateral system, its economy in gages and its other advantages.

The greatest economic value of labor is found in quantity production of mating parts by interchangeable manufacture. The interchangeable system also gives to the consuming public the greatest value for the purchase price of an article and the best service in renewal of repair parts. As a direct result of interchangeable manufacture the cost of many commodities is brought within the means of the masses, thereby still further increasing the economies to be derived from quantity production.

Some localities and countries have progressed more in the application of interchangeable manufacture than others and have thereby reaped greater profits and obtained better business footholds. It would seem that recognized standard practice in such countries, evolved after years of experience, should be most carefully considered before being discarded as wrong.

There are several degrees of interchangeability, or at least several meanings to the exact interpretation of the term.

"Strict interchangeability consists in making the different parts of a mechanism so uniform in size and contour that each part will fit and properly function in any one of the whole number of mechanisms, no matter when or where it is made. It will be noted that this definition means that each part of the mechanism of a certain model will fit any of the mechanisms of the same model, regardless of the lot to which it belongs or the year it was made.

"Some interchangeability consists in making each part fit any mechanism in a certain series, that is, the interchangeability exists only in the same series.

"Selective assembly is often termed interchangeability but it is merely assembly without fitting. It is used where close work and good fits are desired and consists in selecting by trial the largest internal members and assembling them with the largest external members, thus limiting the freedom of fits and still allowing a reasonable tolerance in machining. The following example will illustrate this: If ten one-inch holes should vary from standard size to 0.001 in. oversize and ten shafts were selected from a lot which gave the desired kind of fit in each pair of mating parts, they would function properly without fitting, but it is evident that the largest of these shafts would not interchange with the smallest holes and give the desired results if good fits were required. Therefore, interchangeability by this method is very limited.

"It will be noted that the definition of strict interchangeability given does not necessarily mean that the parts must be made without hand work, although that is usually considered desirable. It does mean, however, that when the mating parts are completed, by whatever process, they must assemble and function properly without fitting individual parts one to the other. On this point hinge some of the controversies on interchangeable manufacture and the advisability of its application.

"It must be realized that the rapid production of a large number of interchangeable parts such as was demanded during the world war, necessitates their manufacture in a number of separated shops. For all of these parts to be within the specified limits for size, requires that each shop must first have a master gage representing these limits.

"To produce a number of master gages which shall be identical within very close limits requires standards that are accurate and identical all over the manufacturing world, or the master gages would have to be made by a single concern which had accurate standards. If master gages were made by gage makers whose standards were not accurate, there could not be strict interchangeability of the parts made to them. Thus the immense value of the accuracy of the standard gages is obvious for the purpose of verifying gages of all kinds.

"In a pair of mating parts that move freely, there is a space or clearance between the mating surfaces. This space is large or small, according to whether the fit is loose or tight. If this space be gradually reduced, a condition will ultimately be reached in which there is no space or clearance between mating surfaces; that is, they fit metal to metal without shake. Then any movement of the parts,

Quotations are all from previous papers on kindred subjects written by the author.

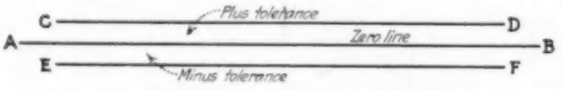
one within the other, will require some force if the surfaces are accurate and smooth and both members are of the same size. When this conditions of mating parts exists, then the dimensions of the parts making this fit should be the exact standard or basic value."

This is the point at which interference of metal begins. I have termed this the zero point and a series of these points the zero line. Tolerance on external members is plus or above this line and tolerance on internal members and allowance, if any, is minus or below this line, as shown in the illustration herewith.

This zero line is then the place at which interference of metal begins to take place, and the zero line should represent the exact standard of basic value of the dimension because a correct pair of mating standard gages checks the dimensions of a pair of mating parts against interference. This means that the minimum dimension of the external member and the maximum dimension of the internal member of a pair of mating parts that fit without shake, are standard or basic.

This fit without shake, is the hardest kind of fit to make and standard gages bought in the open market are the "go gages" for this fit and immediately check an interference of metal.

Strict interchangeability can be maintained only



GRAPHICAL SKETCH OF ZERO POINT

when the interference of metal, or zero line, between mating parts takes place at a fixed relation to the basic or standard dimension.

This seems so obvious that it scarcely needs explanation. It must be plain that if every locality and every country agreed that the zero or interference line should be 0.001 in. over basic and worked to this system, interchangeability could be maintained.

It must be equally plain that if one locality or country adopted the plan of having the zero line or point at which interference takes place 0.001 in. over basic or standard, another 0.001 in. below basic or standard, and still another, at a point exactly agreeing with basic or standard, there could be no strict interchangeability in mating parts among these three countries.

Such a condition is analogous to a variation in the values of standards. Suppose the American inch was 0.001 in. smaller than the British and 0.002 in. smaller than the French, interchangeability of product among these countries would be lost; the product nearly worthless; the economy aimed at lost because the product would have to be special for each country, and the low cost due to quantity production would thus be unrealized.

It is impossible in my judgment to put too much emphasis on the basic or fundamental fact that, where interchangeability is desired there must be a fixed and unchanging point in relation to the basic or standard at which the interference of metal takes place. The master gages or standard gages of nominal sizes ordinarily available everywhere, conform to the fundamental that they are produced under ideal conditions and are identical within any limits now being discussed. A system dependent directly on these standard gages for checking the wear limit of the "go gages" is inherently superior to one dependent on another set of master gages whose limits vary from the standard gages of nominal sizes.

The unilateral system of tolerances complies exactly with this basic principle. The bilateral system of tolerances violates this basic principle.

Strict interchangeability demands control of the dimensions of the minimum external and maximum internal members. If the interference of metal is intentional, as in tight fits, control of these two dimensions is also the important factor as well as in free fits in order to prevent the assembly of mating parts that are too tight. There should be no confusion or misunderstanding in regard to the assembly of mating parts by interchangeable manufacture—the parts will assemble and function when no external member is smaller and no internal member is larger than the prescribed limit. If a system is set up which intends the use of worn gages, these basic truths are cast aside because gages do not wear uniformly in either size or contour and hence cannot control either limiting dimension when worn.

It is a delusion to think that either on account of gage wear, gage tolerance, or for any other reason, the zero point can be crossed without destroying practical and economical interchangeability.

For analysis and comparison I will use a hole for three classes of fit: Snug, 1 in. $\pm$ 0.0005; free, 1 in. $\pm$ 0.001; loose, 1 in. $\pm$ 0.002, as dimensioned by the bilateral system. A glance immediately indicates three minimum as well as three maximum holes. The zero point or interference of metal takes place respectively 0.0005 in., 0.001 in. and 0.002 in. below the basic size 1.0000 in. This will require three "go gages" none of which are basic, all being special. The pieces made in large quantities will have to be kept stored separately to obtain the kind of fit desired and prevent an interference of metal with shafts made for a higher grade of work than mated for where the minimum hole occurs.

These gages cannot be handed down to the next succeeding poorer grade of fit without refinishing because they will be worn taper. There will also be the cost of re-marking for the new class of fit. The same may be said of solid reamers. From the largest solid reamer that could be used, to the smallest for all three fits before it is thrown away, there is a wear of 0.004 in. under ideal conditions.

Using the same examples by the unilateral system the hole dimensions are:

$$\text{Snug Fit, 1 in., } \frac{+\ 0.001}{-\ 0.000}\text{; Free Fit, 1 in., } \frac{+\ 0.002}{-\ 0.000}\text{;}$$

$$\text{Loose Fit, 1 in., } \frac{+\ 0.004}{-\ 0.000}\text{.}$$

We have at once one uniform minimum hole and that is basic 1.0000 in. The standard 1-in. plug is the "go gage" for all three classes of fits. The interference of metal takes place at the same unvarying zero point, the basic dimension. There is required one standard gage for the "go gage," which can be bought in the open market, for all three fits as against three special "go gages" by the bilateral system. There is no difference in gage cost in either system for the "no go gages."

In manufacture, the holes are quite commonly (and may well be) made with the same tools; in either system inspection will pass all holes which the "no go gage" for the snug fit class will not enter.

In the unilateral system, if the same go gage accepts all of these pieces as well, every one of them can be used for interchangeable assembly for any one of the three classes of fits without further classification.

In the bilateral system three inspections with three different "go gages" will have to be made and the holes belonging to each class of fit kept separate, with attendant trouble and losses.

The wear-life of a tool depends, all factors being alike in each case, on the amount the tool is over the minimum hole size at the beginning of its life, and not on the relation of the size to the basic or standard. It is the practice in the United States to make all solid reamers slightly over basic for wear life, and not exactly standard, as some British engineers suppose.

In interchangeable manufacture in the United States, it is the predominating practice to use adjustable reamers, returning them to the tool room for correction as soon as the standard plug-gage will not enter the holes. Years of experience have taught us that this procedure maintains accuracy and quality of holes at a low cost, at the same time enables us to transfer the skill of a good tool maker through the tool room to the machine operators and, best of all, provides for strict interchangeability.

Easier to Dimension Drawings in Unilateral

It will now be shown that the work of dimensioning and revising of tolerances on drawings is less, for the unilateral system requires less mental effort and therefore tends toward economy and accuracy.

"It is almost universally agreed that allowance or minimum clearance is a designer's term and from his standpoint the important factor in a fit. This is certainly true if the designer is really competent and, as he is responsible for the proper functioning of the mechnism, he has a right to insist on the accepted fundamental—'allowance (neutral zone or minimum clearance) must never be encroached upon from any cause.'"

The important factor, from the manufacturing standpoint, is the tolerance allowed. Thus allowance and tolerance are each required by two different parties, sometimes so widely separated as to never even see each other. They must not, therefore, be confused nor tampered with by the wrong party or trouble will ensue.

To illustrate, I will take as an example a hole with a free running shaft and as a designer I decide that the allowance my experience indicates is 0.001 in. That is, I will make the hole 1.000 in. standard and the shaft 0.999 in. This represents my ideal condition of this pair of mating parts for the job intended. If I were to make only one pair, this is all that is necessary and the toolmaker could make the parts without trouble. I have established the fact that I want 0.001-in. clearance or allowance between the mating surfaces of this pair and this is minimum.

The job functioning properly with the above allowance, it is desired to make, say 10,000 of these pairs and it is decided to allow 0.001-in. tolerance on each member. The dimensions then become (by the unilateral system):

$$\text{Hole, } 1.000 \text{ in.} \begin{matrix} +\ 0.001 \\ -\ 0.000 \end{matrix} \qquad \text{Shaft, } 0.999 \text{ in.} \begin{matrix} +\ 0.000 \\ -\ 0.001 \end{matrix}$$

It will now be seen that the main dimensions show at a glance what is the allowance, or the tightest fit. Attention is also called to the fact that these main dimensions also represent what is commonly called "maximum metal." Increasing the metal in either member will make a tighter fit than is permissible. This then should be the rule for dimensioning drawings—"Main figures indicate maximum metal or tightest fit permissible."

"Tolerances should always be applied in a direction to produce greater looseness of fit, as this is the only sacrifice that can be permitted for variation in manufacture."

If for any reason tolerances must be changed, a single dimension for each member only requires changing and the tightest fit is not interfered with. It will be noted that changing the tolerances on either of these members permits the use of the same "go gages" without change.

In the bilateral system the designer, having established his tightest fit at the same dimensions, i.e., hole 1.000 in.; shaft, 0.999 in., applies the tolerance to the hole 1.000 in. ± 0.0005, and this establishes his minimum hole as 0.9995 in., from which he subtracts 0.001 in. for his allowance. This gives him the maximum shaft 0.9985 in., from which he again subtracts his 0.001 in. tolerance, arriving at the minimum shaft as 0.9975 in. He may dimension these parts several ways thus:

$$\text{Hole} = 1.000 \text{ in.} \pm 0.0005 \text{ in.}; \qquad \text{Shaft} = 0.998 \text{ in.} \pm 0.0005 \text{ in.}$$

$$\text{or} \quad \text{Hole} = \begin{matrix} 0.9995 \text{ in.} \\ 1.0005 \text{ in.}; \end{matrix} \quad \text{Shaft} = \begin{matrix} 0.9975 \text{ in.} \\ 0.9985 \text{ in.} \end{matrix}$$

$$\text{or} \quad \text{Hole} = 1 \text{ in.} \pm 0.0005 \text{ in.};$$

$$\text{Shaft} = 1 \text{ in.} \begin{matrix} -\ 0.0015 \text{ in.} \\ -\ 0.0025 \text{ in.} \end{matrix}$$

In none of these can the tightest fit be seen without considerable mental effort. Changing the tolerance on the hole means changing one dimension by the first and third method of dimensioning or two by the second method. Changing the tolerance on the shaft when the hole has been changed as well, means changing two dimensions regardless of which of the three methods he uses, with the attendant extra mental effort and chance for error.

Attention is called to the fact that changing the tolerance destroys the old zero point at which interference of metal takes place and sets up a new one, which may in many cases prevent the assembly of parts previously accepted. This would plainly interfere with the service of furnishing renewals that would fit.

It is to be noted also that both the "go" and "no go gages" for each member are no longer acceptable for the new dimensions, but must be at least partially retained to make repair parts for those mechanisms made before the tolerances were changed, or they may not fit.

My experience, covering thirty years of active work in connection with both the making and use of tools for accurate manufacturing by all of the systems in use during that time, leads me to believe beyond question that the unilateral system of tolerances has the following proved advantages:

(a) It provides the only practical means of maintaining strict interchangeability in manufacture.

(b) It is more economical to manufacture by this system due to its simplicity.

(c) The gage cost is less.

(d) The cost of dimensioning drawings is less.

(e) The mental effort of dimensioning drawings is less.

(f) Tolerances may be changed without destroying the zero point at which interference takes place. Changing the position of this zero point may prevent the assembly of parts already made.

(g) It permits the standard calibrated gage to settle any controversy regarding the interference of metal between mating parts.

(h) It permits the standard calibrated gage to control the minimum dimensions of the external member.

(i) It simplifies the handling of small tools and gages in the tool room.

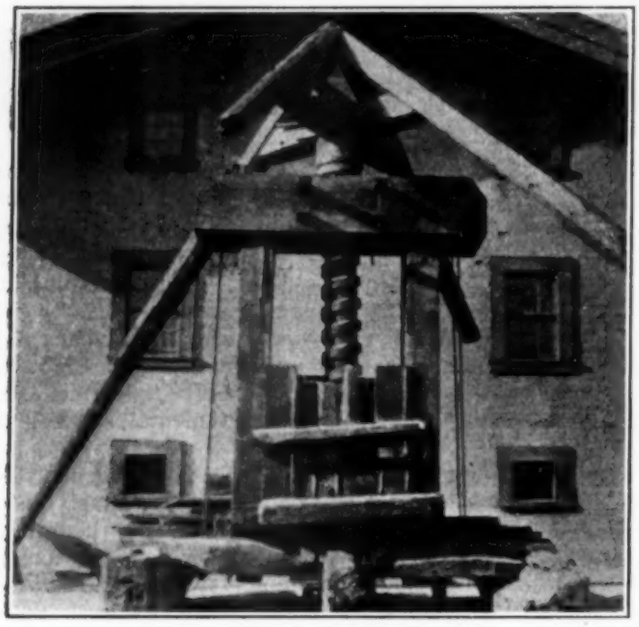
Ideas from Practical Men

Devoted to the exchange of information on useful methods. Its scope includes all divisions of the machine building industry, from drafting room to shipping platform. The articles are made up from letters submitted from all over the world. Descriptions of methods or devices that have proved their value are carefully considered, and those published are paid for

Old Hay Press with Hand-Cut Wooden Screw

BY HERBERT E. CRAWFORD

Here is a good example of the way our grandfathers had to do things when they needed machinery of any kind. The illustration shows an old hay press or a



A HAND-CUT WOODEN SCREW

machine which dates back many years and is now among the relics preserved at the old Fort Sutter Museum, Sacramento, Calif. The exact date is not available.

The screw is of wood, about 10 in. in diameter and the thread was cut by hand. The man who laid it out and cut the thread would probably have balked at working to a sixty-fourth of an inch, but most of our present-day mechanics who split thousandths, would be stumped to tackle such a job as this.

Its a very fine-looking thread, although the accuracy of its pitch, diameter and lead, is probably open to question.

Indexing a Shaft Without a Dividing Head

BY U. S. LATTNER

The following described method of indexing or spacing splineways on a shaft may be fonud useful when there is no dividing head available or when the nature of the work precludes the use of such a head.

Place the shaft in V-blocks on the table of the milling machine, line up and center it in the usual manner and make the first cut. Next clamp a smaller V-block to some part of the shaft that is not to be milled, using as small a clamp as possible for the purpose, and squaring the side of the block with the table.

Compute the angle between the cut already made and the next cut to be made and set a bevel protractor to this angle. Loosen the clamps that are holding the work and turn the shaft until one side of the small V-block is brought to coincide with the angle of the protractor.

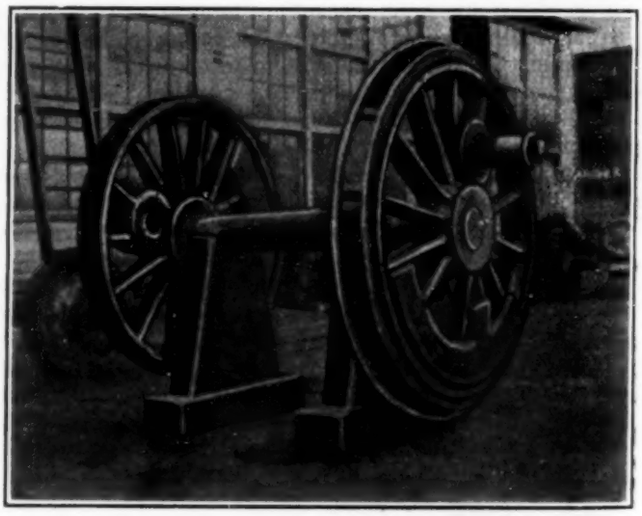
If the supporting V-blocks are high enough from the table to permit the smaller block to swing clear, the remaining setting of the shaft may be made by resetting the protractor to each successive angle; otherwise it will be necessary to reset the small block square with the table each time and leave the setting of the protractor undisturbed.

If the nature of the work will permit, it may be held in the regular milling machine vise instead of in V-blocks.

Pedestals for Holding Locomotive Wheels While Shrinking Tires

BY I. B. RICH

The pedestals or blocks for holding locomotive axles while removing old tires from the driving wheels or shrinking on new ones, in use at the Tacoma shops of



PEDESTALS FOR TIRING WHEELS

the Chicago, Milwaukee & St. Paul Railway are shown herewith. The pedestals are not of cast iron, as one might suppose, but are built of substantial timbers and covered with heavy sheet steel, so as to be immune from the heat of the burners used in heating the tires. They are light enough to be easily moved and yet substantial and have a long life as well.

Calipering the Tenth Part of One Thousandth of an Inch

By Wm. S. Rowell

As optical flats and other highly refined methods of measuring cannot be used in all cases, a little attention to the humble two legged caliper of our fathers may prove to be time well spent.

Despite serious handicaps placed on them by their introducers, both inside and outside micrometers have slowly grown into very general use. The outside micrometer has about driven outside calipers from use among toolmakers, but because of the difficulties of using inside micrometers in small openings, the inside caliper still holds its place in the kits of the best work-

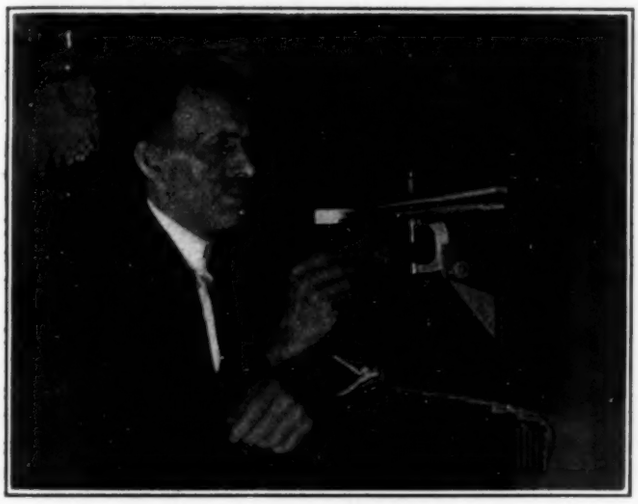


FIG. 1—THE APPARATUS IN USE

men. It is in every day use by many, and occasional use by all, and very often we want it to decide a dimension with less than 0.001 in. variation.

Setting out some time ago to learn what degree of accuracy might be expected in the use of inside calipers by trained men, the writer found that the men who can be depended on to caliper a hole—say from ½ to 1 in. in diameter to less than 0.001 in. are not overly plenty, and those who can be depended on to detect less than 0.0005 in. with an inside caliper are rare indeed. To help decide what might be done along these lines a machine was made as here described.

An outside micrometer of reputable make and known accuracy was mounted on a wooden stand and the thimble provided with an index of beaver board terminating in a point at one end. The index was 32 in. long and pierced near its center for the thimble. This index was held in position by sealing wax. Another piece of beaver board was similarly mounted and fastened to the micrometer hub. This latter piece carried a graduated segment of a circle 32 in. in diameter to be traversed by the point of the index as the micrometer screw was rotated slightly. Fig. 1 shows this device.

It will readily be seen that with this arrangement, the space on the scale passed by the index point during a movement of 0.0001 in. would be appreciable—about 0.402 in.—instead of the microscopic and doubtful space that shows a like movement on the vernier of an ordinary micrometer. In testing a man's ability to use inside calipers accurately, the micrometer is opened a random amount, the index point being over the central portion of the graduated segment. He is then asked to set his calipers accurately to the opening. With a newspaper held between him and the index a slight change is or is not made, and he is asked to decide by the use of his set calipers what was done and how much of it. That is, was the opening increased or diminished and how much, or was it left as it was, he being privileged to use a micrometer before deciding.

It was realized that measuring between the flat, parallel surfaces of the anvil and spindle of a micrometer is much easier than measuring in any kind of a hole; but the task of providing a series of round, parallel and smooth bores varying 0.0001 in. each from the next size, gave me pause. The following substitute was hit on and worked satisfactorily:

A thin ring of tool steel about 1 in. inside and 1.020 in. in outside diameters and about 0.3 in. wide was carefully made and mounted between the measuring surfaces of the micrometer. It was held in place by small pieces of fiber about 0.020 in. thick, as shown in Fig. 2. The fiber pieces were bored a slightly loose fit for the micrometer anvil and spindle and with the help of wax, held the steel ring in place.

With this arrangement a man's ability to measure a hole accurately could be tested in the same way as before described. The ring is slightly compressed before the first setting of the calipers, and its elasticity takes care of any desired variation in size.

The tests made tended to show that any trained man could detect a variation of 0.0005 in.; that a few could detect a change of 0.00025 in. and occasionally, but *rarely*, a man was found who generally decided the direction of change when it was only 0.0001 in. Summing up the results the writer would say: With nine out of ten trained men, working to 0.0005 in. variation of bore is all that can be expected. One man in ten may attain a dependable accuracy of 0.0003 in. and a very few—possibly one in fifty or one hundred—may be found to reduce that slightly. In other words: Working to less than 0.001 in. variation with inside calipers and outside micrometer is working among uncertainties and attempting to decide sizes to 0.00025 in. is working in the region of great uncertainty. A man may be better able to detect a variation of 0.00025 in. at one time than double that amount at another and not know why.

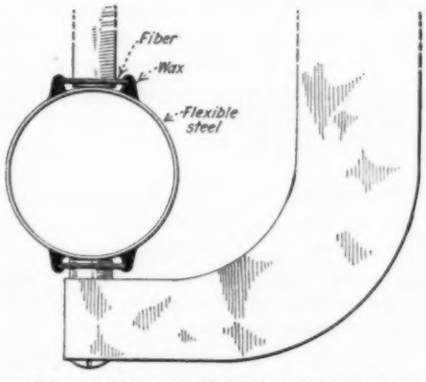


FIG. 2—HOW THE RING WAS HELD IN PLACE

One of the interesting little things learned in calipering between the flat polished surface of the micrometer anvil and spindle was that the conditions supplied by the machine described made it possible to hear the contact of the caliper with the micrometer spindle, when too slight to be felt by any one. The beaver-board seemed to supply a form of microphone.

If any one develops anything from this that will improve instruments now in use, the writer will be pleased to know it.

Placing Pattern Numbers on Patterns and Castings

By Frederick Franz

Pattern numbers are placed on patterns in order that the patterns and the castings may be identified. It therefore seems absurd that in most plants so little care is taken to effect this object.

The responsibility should rest with the engineering department. The detail drawing of each casting should give the complete information which should be strictly followed by the pattern maker. Fig. 1 shows a successful method of indicating this information. It indicates a pattern plate attached to the under side of the patterns. The draftsman can best letter these numbers by turning the tracing on its face and lettering, as usual, on the back of it. Pattern plates attached to the upper side of the pattern, would be indicated in full lines instead of dotted lines and would not show reversed numbers. The practice of painting pattern numbers on patterns is not good, for the difference in cost, if any, is slight and castings from them can not be identified. The patterns themselves soon become covered with a layer of foundry sand, dirt and dust, which conceals the painted figures.

Two good methods of placing numbers on patterns are in use. By plate numbers, referred to above, which are embossed in consecutive order on a strip of soft

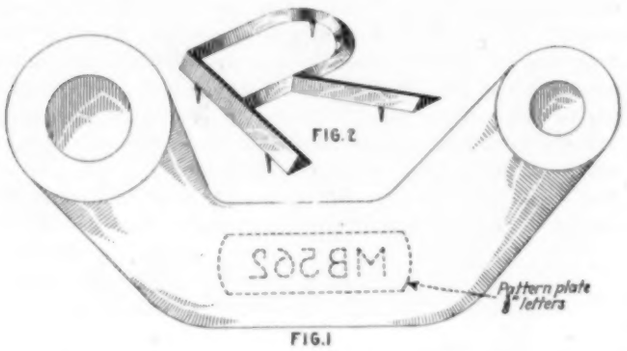


FIG. 1—DRAWING OF A PATTERN WITH PATTERN PLATE ATTACHED. FIG. 2—A DIE-CAST NUMBER SHOWING TRIANGULAR SECTION

zinc, and attached as one unit to the pattern and by die-cast numbers which are individual numbers and must be applied individually to the pattern.

Pattern plates should be bent slightly concave before tacking them to the pattern in order to prevent foundry sand from working under them and bulging them. Pattern plates should not be used for steel castings owing to the fact that the embossing is not deep or sharp and the sluggishly flowing metal does not fill their impression well. What little impression is made in the raw casting is generally rendered illegible by the scale from the annealing or the tumbling process. The height of the number is measured from centerline to centerline of the width of the lines forming the number. This should be considered in estimating the overall height of the number. The fact that the embossing machine will stamp only one height of number should also be considered. The draftsman should obtain the height from his pattern maker.

Die-cast numbers are made of white metal. The lines forming the number are generally of triangular section, as shown enlarged in Fig. 2. They may have prongs to be driven into the pattern, or they may have plain flat backs. The later type are attached to the patterns by applying a coat of shellac to the pattern, setting the numbers in place, allowing the shellac to dry, and then giving them another coat or two of shellac. They are knocked off the pattern and lost much easier than those having prongs and should not be used except when necessary, as for instance on a thin wood pattern of a name plate in which the prongs of the many letters in the name plate would be likely to warp the thin wood pattern. Letters without prongs should only be considered when only one casting of a pattern is required.

The Size and Location of the Numbers

Die-cast numbers under $\frac{3}{16}$ in. high should not be used on any casting, and die-cast numbers under $\frac{1}{4}$ in. should not be used on steel castings. It is preferable to use, and there generally is no objection to using, a $\frac{1}{2}$ or $\frac{3}{4}$-in. letter if the space is available. The difference in price is negligible, and the ease of reading the large number is appreciated by the men in the shop who must identify the patterns and the castings.

We are now ready to consider the proper location of the numbers on the patterns and castings. There is a strong opinion among some folks that pattern numbers should not be placed directly on the outside of a machine, where they silently stare at all observers. I share this opinion when the pattern numbers are large and are placed on large parts like the front of the main frame for instance, when they can be placed in a less striking location and yet be readable. But if they are not readable without entering the inside of the machine, dismantling it, or crawling under it, no hesitancy should be felt to put them on the front of the machine. The numbers on the parts of small mechanisms generally do not invite attention, and should be placed for convenience in reading.

The number should also be so placed on the pattern that it is not machined off, yet this is frequently disregarded as if it were the desire to cut it off "after it has served its purpose." It has only completed its purpose after the part on which it is cast is worn out or has broken, by affording a means for ordering a replacement part. To be sure, some castings are machined all over, and cannot be identified by a number but must be described.

Limitation on Location

Desirable locations can not always be effected owing to the limitations of molding. A compromise must then be made. When one side of a pattern is flat, the molder will invariably put that side down on a board and ram his drag over it, if the pattern casts that way. Hence pattern numbers should not be placed on the flat side of such a pattern for the pattern will not lie flat on the board thus interfering with the molding, and in addition the numbers will soon be scraped or torn off the pattern. Pattern numbers must, of course, be so placed that they will draw from, and not across the sand, yet I have frequently observed that draftsmen who fully understand this fact will err in this respect, in indicating the location of the numbers.

If the object of pattern numbers be borne in mine—that they are not only for use in the records of the drawing room and office, but also for the saving of time of the pattern maker, pattern storage clerk, molder,

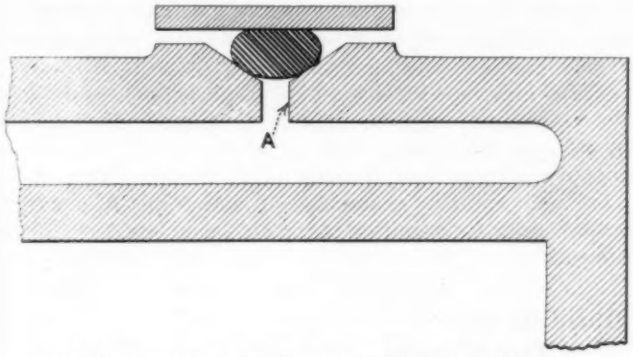
foundry shipping clerk, machine shop raw and finished stock clerk, machinist and his foreman, assembling department, the user of the machine, and the draftsman himself when he is assigned to find a certain pattern, say number VKF-257-B, in the pattern storage—there will be more consideration given to this small but important item in machine design.

Preventing Cylinder Jackets from Cracking

By H. F. Crawford

The Western Machinery Co., of Los Angeles, Calif., builds gas engines for use in connection with oil-well work, as well as other machinery. One of the difficulties encountered at times was the cracking of the water jacket walls, due to a combination of internal stresses and the differences in temperature of the inner and outer walls of the cylinders.

The very simple and effective expedient was adopted



RELIEVING STRESSES IN CYLINDER CASTINGS

of designing the water jacket so that it could be cut through the outer wall with a parting tool, as shown at *A*. A band was left for turning on the outside. The parting tool was fed in, cutting through the outer wall into the water space and the outer edges were beveled on each side. It frequently happened that the internal stresses, released when the tool broke through, caused the metal to pinch the tool.

A round, soft rubber gasket was put into the groove made by the beveled edges and a flat band clamped on the outside, over the turned portion, to hold the rubber in the groove. This method has proved entirely successful in preventing cylinder jackets from cracking in service.

Re-planing a Lathe Bed Without a Planer —Discussion

By T. C. Taylor
Essex, England

On page 268, Vol. 58, of the *American Machinist*, there is an article by W. C. Pope on re-planing a lathe bed without a planer. It is an ingenious and useful idea.

I have done a somewhat similar job, namely, re-planing the steam-chest face of a large engine cylinder without a planing machine. I obtained the driving power by fixing one end of a joint or connecting rod to the slide rest. The other end was attached to a large faceplate fixed to an old lathe headstock, which was then belted up at a convenient spot in the shop, giving the required reciprocating motion.

Mr. Pope states he withdrew the tool at each return movement to relieve the point. This I found to be entirely unnecessary as the cuts taken were only of a light character.

[It would be much more difficult to apply power on such a long travel as a lathe bed than in the case of the steam chest mentioned, and it might easily happen that the cost of arranging to use power would be much more than the labor charge for 7½ hr., as in Mr. Pope's case.—Editor.]

Finishing Work in the Foundry

By Frank C. Hudson

Eliminating machine work by clever foundry practice has long been a feature in agricultural plants, but it is not confined to this class of work, as these two examples from the Pacific Foundry Co., San Francisco will show.

The work shown in Figs. 1 and 2 comes within the plumbing field although it is made for a special class of apparatus. The return bend shows in Fig. 1 has the loose flange *A*, by which it is held in place. As can be seen the inside diameter of this flange is smaller than the outside of either end of the return bend so that it cannot be put in place after the bend has been cast.

The flange is cast separately in another mold. The pattern for the return bend has a print which makes a place for the flange in the mold before the bend is cast. The inside of the flange is protected by mica, and slipped over the cove of the return bend, both being placed in the mold in the usual manner. Then the bend is cast, the mica preventing the joining of the metals and allowing sufficient clearance to move the flange up into its proper position. The dotted lines show the flange in the mold.

Another very clever method of saving machine work is shown in Fig. 2. Here the pipe is of a very hard iron where threading is not to be considered if it can be avoided—and it can.

The piece is cast with a flange at *A*, a rib on each side at *B* and a collar at *C*. A piece of heavy pipe is threaded with a straight die, cut off the proper length and cut

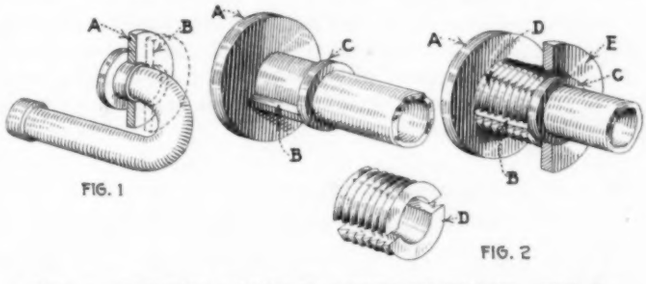


FIG. 1—CASTING LOOSE FLANGES IN PLACE. FIG. 2—PUTTING STEEL THREADS ON A CAST IRON PIPE

into two pieces with enough removed to allow for the ribs *B*, as shown at *D*.

Then the two threaded pieces of the pipe are placed over the casting as shown at the right and the threaded flange *E* screwed over them. The ribs prevent the threaded pieces from turning and the flange and collar hold them endwise. Altogether it makes a combination which ought to have other applications.

American Machinist
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KENNETH H. CONDIT AND FRED H. COLVIN
Editors

May 10, 1923

Tendencies In Securing Production

THERE SEEMS to be a tendency on the part of production engineers to utilize special fixtures on standard machines rather than have special machines designed for particular pieces of work. This is very noticeable in the case of milling machines and probably applies with equal force in other lines as well. True, some of the special fixtures include the addition of auxiliary milling cutters but they are all driven from the main spindle and, with the fixture removed, the machine is a standard machine as before.

Continuous operation, or the cutting down of lost time between cuts, is also receiving careful attention. Keeping the tool continuously at work, or with as short a gap between machined surfaces as possible, seems to be the watchword. Loading one part of the fixture while cutting tools are working on another piece is a cardinal principle in securing maximum production.

Closely connected with this is the study of clamping methods, of means for locking and releasing the parts to be machined with the least effort and in the least time. The urgency of this, however, depends on the nature of the work and the time available between cuts.

The necessity of saving time between loading the machine is too often not fully considered on large work where it is most urgently needed. In too many places the table of a large machine will be used as a laying out table instead of having fixtures into which the piece can be put with little loss of time. The more hours per day a machine is at work the greater the dividend it can earn. The idle time of a large, expensive machine is frequently more costly than the day's wage of the man who runs it.

A study of these tendencies is encouraging as being a step in the right direction. Production men and tool and fixture designers will do well to note some of the work which is being done along these lines in various sections of the country.

More Use Should Be Made Of the Manufacturers' Knowledge

A TOOL ENGINEER may solve his unusual problems by working them out himself, by getting his information through reading, and by making use of the service of the manufacturer of the tool with which he is dealing.

From the viewpoint of personal achievement possibly the method of plain thinking it out gives most satisfaction. From an economical viewpoint, probably either the second or the third, or a combination of those two methods is best.

The esteem of the mechanical man for the technical paper and his constant acquisition of books show that he relies upon using or adapting the methods of others. By their means his task is the more quickly accomplished and he is free to take up another.

How much the tool engineer depends upon the manufacturer is problematical, but quite likely there is not enough of that kind of dependence. Yet right there good and plentiful help awaits his asking. Use, for illustration, the chuck, one of the simplest forms of holding device. Three- and four-jaw chucks are used in every shop, and for the most part used efficiently. But the two-jaw chuck with its limitless variations of jaws, the air chuck, and the special chuck, are types used too infrequently, and much of the time without obtaining their full value. The chuck maker knows how they should be used and if he had the problem of the tool engineer before him could draw upon extensive experience in solving it. He can't hunt up many of these problems—they must be given to him. And it must not be forgotten that chucking work has advanced along with other phases of production during the last ten years.

Chucking work has been used as an example only, and the statements may be applied to almost all types of machining operations. Not all of the service suggested should be free, though much of it would. Even if all were paid for, the economies of obtaining information where that information is most complete, would be appealing.

Building Up Tire Flanges

AMONG THE more recent uses of the electric arc, and also of the gas torch, the building up of worn tire flanges seems to be growing rapidly. It is a comparatively easy matter to fill in a worn flange and so increase the life of the tire, as well as saving the necessity of removing it from the wheel center.

Metallurgists who have looked into the matter very carefully, however, contend that this is a dangerous practice and one that should not be countenanced by any railroad. They are convinced that the degree of local heating necessary to weld new material into a worn flange applied in such a strictly local manner cannot fail to injure seriously the structure of the material. The effect of an injury of this kind is to set up internal stresses which start innumerable incipient cracks from which larger cracks and serious breakages may easily occur.

Locomotive tires and truck wheels play such an important part in the safety of railway transportation, particularly at high speed, that many engineers feel very strongly that no welding of wheel spokes, hubs and tires should be permitted. They contend that no inspector for a railroad would accept a new locomotive with defects in wheels patched up by welding and that the same standard should be maintained during the life of the locomotive.

In any case it behooves railway officials who are welding either tire flanges or cracked spokes in wheels to keep a careful record of their performance.

Frightened by the Threat of Prosperity

MOST PEOPLE would feel small apprehension if prosperity and good business were held over them as a threat. And yet there are some to whom good times are a very real danger. Prominent among them are the railroad executives.

Just why railroad men should worry over impending prosperity is not hard to see. They are seriously short of rolling stock and motive power and too much of what they have is on the sick list. They have placed large orders for all kinds of road equipment but as they have all done so at the same time they have pretty well swamped the builders and will have to wait their turns on deliveries. Some shops are booked full for two years.

Putting off the purchase of new equipment until so late in the game is certainly poor business but most of the railroads have had no other choice. Until their incomes exceeded their fixed charges there was little chance of finding the money for locomotives. And now they will have to pay more for what they get than would have been the case had they been able to order a year or so ago when the shops were not busy.

Add to this situation the fact that very few railroad shops have equipment anywhere near adequate to repair modern locomotives and you can realize why prosperity is a serious matter for the railroad people. For car loadings established new records in March and the transport of materials for the spring highway work alone would absorb all the available surplus cars if the road contractors were not held down to only their fair share of cars.

Machinery men have been experiencing trouble lately because of embargoes on certain parts of the country. We hate to sound a pessimistic note but we nevertheless believe that the freight troubles ahead will be worse than those behind us. Here is something for the shipper to think about and pass on to his representatives in Congress when he gets enough wrought up about it. We have been promised radical railroad legislation on the convening of the next Congress. Perhaps things will happen in the meantime to show the new members where the fault lies and prevent them from making matters worse. Let's hope so.

Licensing the Mechanical Engineer

CAN LICENSING improve the status of the mechanical engineer or benefit the society of which the engineer is a part? Thought is due the question, because there is evidently a trend toward licensing all engineers. Some states have licensing laws in effect, others are now considering them, and we can expect even further developments.

The apathy shown by mechanical engineers in general toward licensing laws is a factor to be reckoned with, as it betokens a lack both of thought on the subject and desire for such laws. The land surveyors and the civil and the sanitation engineers have been the particular targets for licensing laws. The reason seems to be chiefly that such professional men stand in closer relation to the community as a whole, and their work as individuals directly influences the health or welfare of the community. Not very many mechanical engineers occupy similar positions because their work is generally done for or through companies or corporations which then take the responsibility for the feasibility and value of the engineering work done.

An excellent summary of the arguments pro and con on the licensing of engineers was published by a committee of the A.S.M.E. reporting on the registration of engineers in New York State. The arguments are worthy of quotation. When speaking of licensing engineers to safeguard life the report says:

"Both affirmative and negative arguments under this head relate to civil engineering, with rare exceptions. Mechanical engineering products which, if improperly designed or constructed, may jeopardize life are: rails, structural steel, high speed machinery, improperly guarded machinery, boilers and elevators, and the like. The chief arguments advanced against licensing mechanical engineers as a body to diminish these risks are that the state already has good laws well administered covering them, so that a license law cannot further safeguard life than do existing inclusive laws drawn specifically for that purpose."

When treating of licensing engineers to safeguard health, it is stated that, "Arguments are rarely, if ever made, that mechanical engineers must be licensed to safeguard health, possibly because the state factory inspection, labor and workmen's compensation laws, and the like, are considered to cover this field reasonably well."

Under welfare there are two distinct aspects, the report says, the welfare of the public and of the engineer himself. "Licensing engineers is claimed by some to be the best way by which the public can be protected against charlatans who will waste the money invested in the work they design and build. The general answer made to this argument is that (1) the low minimum degree of knowledge and experience set for a license, and (2) the impossibility of determining by any practicable form of examination if an applicant possesses the judgment needed to make his knowledge and experience available for responsible charge of engineering work, combine to render licensing practically valueless for this purpose.

"It is frequently claimed that licensing engineers is desirable as giving them an established status in the courts, like lawyers, physicians, nurses, dentists, veterinarians, and druggists, to name a few of the classes forbidden to follow their callings until licensed or registered in some legalized manner. Such a legalized status will, it is claimed, elevate engineering as a profession in the eyes of the public.

"The general answer made to this argument by some opponents of licensing is that if engineers cannot, by themselves, demonstrate to the public by the work they do and by their useful activity in public affairs that engineering is a highly responsible profession, it is pusillanimous to try to accomplish this under the cloak of a license law nominally advocated to safeguard health, life and welfare."

Shop Equipment News

Cincinnati Simplified Gear Hobbing Machine

The gear hobbing machine now being put on the market by the Cincinnati Gear Cutting Machine Co., Cincinnati, Ohio, is shown in Figs. 1 and 2. This machine was designed to produce very accurate gears of a given size in large numbers, and while in general it may be classed as a single purpose machine, it has some special features that make its possible range greater than that of the average machine of its type. The principle involved was developed and tried out in the plant of one of the large automobile manufacturers.

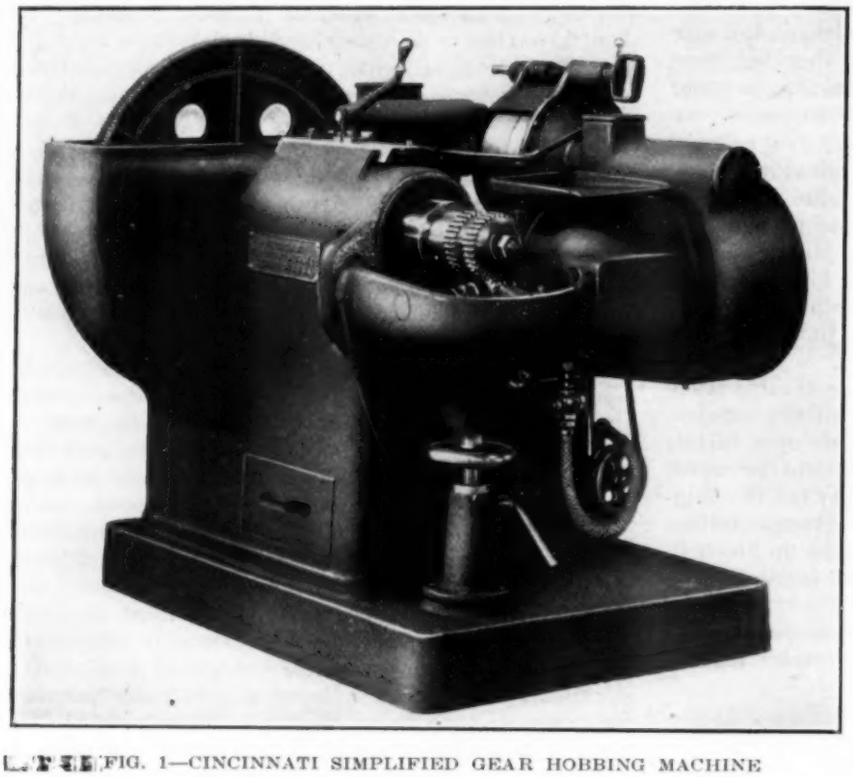


FIG. 1—CINCINNATI SIMPLIFIED GEAR HOBBING MACHINE

The hob of this machine has no movement except that of rotation since the work is carried on a spindle and fed out over the hob, as may be seen by inspecting the positions of the work in the illustrations. The design makes possible an extremely rigid machine of comparatively few parts. This simplicity is emphasized by reference to the index train, which has only two gear contacts and one heavy shaft. A pair of bevel gears, driven direct from the cutter spindle, are connected to the index master gear and its driving pinion by the single shaft referred to. This index master gear is mounted directly on the end of the work spindle and the proper relation between the rotation of the cutter spindle and the work spindle is maintained through these four gears, or two gear contacts, as stated. The spur gears are cut with extreme accuracy but any error which might enter into them from wear is minimized with regard to the work by the master gear which is 34 in. in diameter while the work handle is never over 7 in. in diameter. The machines are furnished equipped with indexing gears and pinions for cutting one number of teeth only, but are adaptable to cutting other numbers of teeth by changing the master gear and pinion.

The work carrier, or spindle, is 6¾ in. in diameter, hardened, ground and lapped. It is mounted in adjustable bronze bushings tapered on the outside. The size of both the work and the cutter spindles is such that no outer supports are needed.

The feed movement is obtained, not by change gears, but by means of a lead screw running in a nut mounted inside the work spindle, and the rotation of the work spindle in indexing advances the spindle and its work according to the lead of the screw provided for this particular job. Change of feed is obtained by changing the lead screw and nut. The feeding mechanism is arranged for rapid traverse, so that when tripped by the operator the work advances rapidly to the cutter, trips into the proper feed, passes through the cut to completion and stops. Work is removed in the forward position and the feed again tripped by the operator. This causes the work spindle to return quickly to loading position back of the cutter.

Cutter Spindle Mounting

The cutter, or bob spindle, is hardened and ground and is provided with two opposed tapered bearings running in adjustable bronze bushings. The cutter spindle is further provided with a thrust collar between these bearings so that adjustment of one does not affect the adjustment of the other. The cutter spindle housing is bored from the solid at the correct angle of the hob. This housing, in addition to the cutter spindle, carries the fly wheel and its 8-thread driving worm. The flywheel weighs 300 lb. and is mounted direct on the end of the cutter spindle and not on an auxiliary shaft, so that its momentum and balancing effect are carried directly to the hob. The hob is set for the proper depth of cut and adjusted to varying diameters of gears by a radial movement of the housing which is governed by a micrometer jack below the chip pan. This radial movement centers about the index driving shaft.

The machine is furnished by the manufacturer for cutting gears of any pitch by providing it with a hob spindle housing bored to the proper angle. These housings are

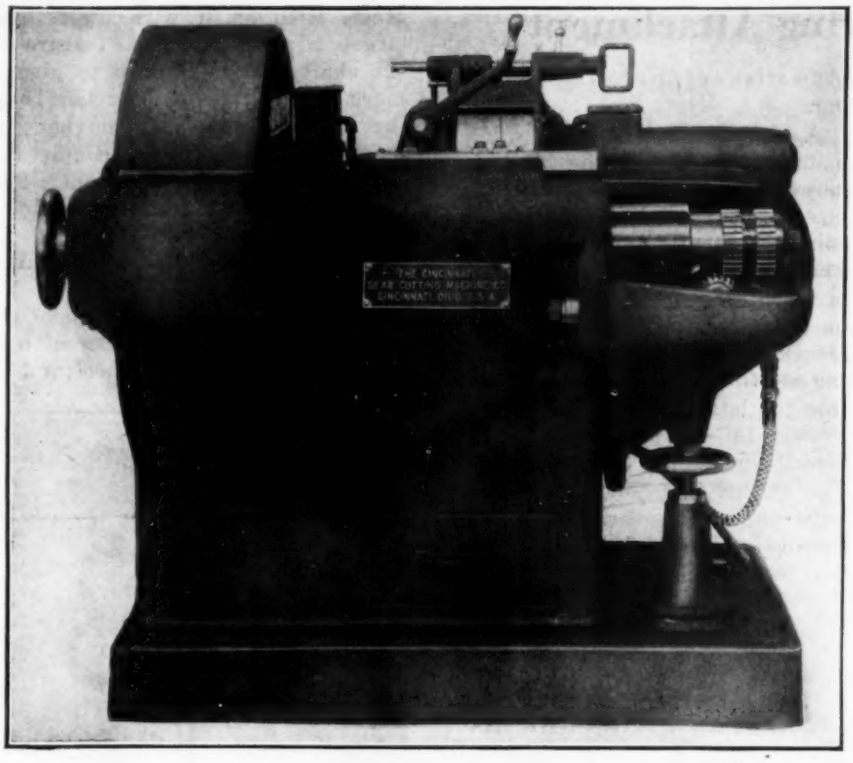


FIG. 2—POSITION OF WORK AT FINISH OF THE CUT

interchangeable and a machine equipped for cutting one pitch of gear may be converted by the user for cutting any other pitch by securing the proper housing.

While any size or bore of hob is adaptable to the machine the use of at least a 4-in. diameter hob with narrow face and 2-in. bore, is recommended. This gives more accurate results than a smaller hob and the larger diameter reduces the depth of the feed marks. Change of cutter speed is obtained by changing the size of the pulley on the line shaft as no arrangement for changing the speed is made in the machine itself.

The machine will cut gears up to 7 in. in diameter, 4½ in. face, 4 d.p., in steel. It weighs 6,000 pounds.

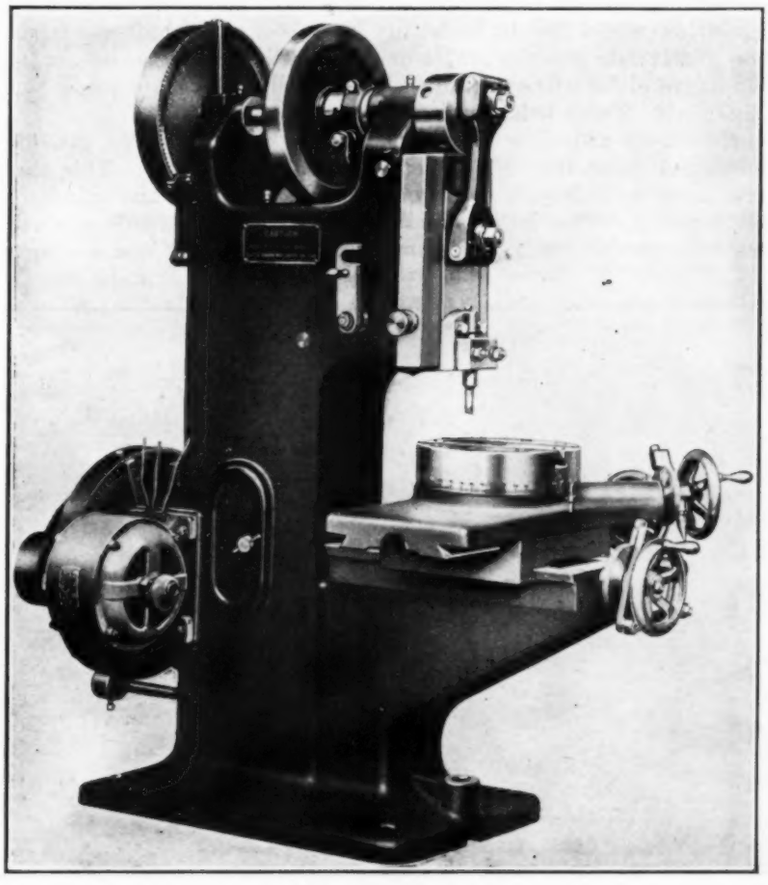
Steptoe Die Slotter

The John Steptoe Co., 2961 Colerain Ave., Cincinnati, Ohio, has recently placed on the market the improved Bossert die slotter shown in the accompanying illustration. This vertical slotter is made in two sizes, one having a stroke of 4 in., and the other a stroke of 6 in., and it is intended especially for use in making round, square and irregular shaped punches and dies.

The ram is driven by means of a crank arm, which is connected at the upper end by a crankpin to the crank disk on the main shaft. A maximum length of stroke of 4 in. on the smaller machine and of 6 in. on the larger is possible by moving the crankpin on the disk. The ways, which are fitted with taper gibs, are hinged on the upper end in such a way, that they can be set at a slight angle to obtain the required amount of clearance when finishing die openings. A pin located in a slot in the ram is attached to the lower end of the crank arm or connecting rod and its position is adjustable in order that the location of the ram stroke may be altered to suit the work.

By means of a pull-pin the lower end of the way may be connected to a toggle-joint mechanism operated by an eccentric on the main shaft. When connected in this manner, the mechanism moves the ram over a curved path on the down stroke, and enables the machine to take curved cuts in the dies. This mechanism also causes the tool to clear the cut on the up stroke, the amount being adjustable.

The machine can be furnished with cross, longitudinal and circular hand feeds and also with power feeds. A variable-speed gear box that is mounted inside the column gives three changes of speed, these speeds being secured by means of a shifting lever located on the outside of the column. A circular table graduated in degrees and provided with an index pointer is part of the regular equipment supplied with the machine.



STEPTOE DIE SLOTTER

Mueller Oil-Grooving Attachment

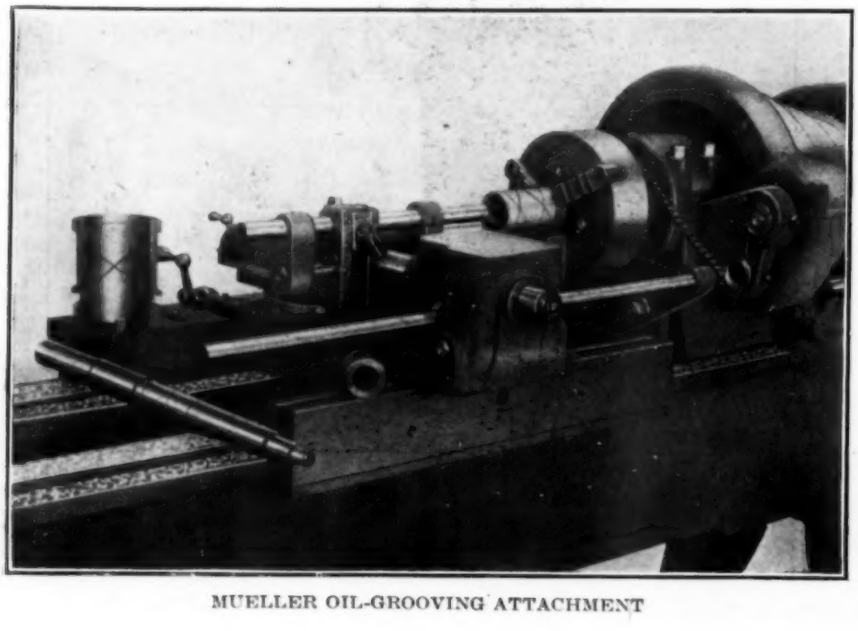
For the purpose of oil-grooving bearings or shafts on an engine lathe the Mueller Machine Tool Co., Cincinnati, Ohio, has recently developed an attachment that will oil groove any diameter work which can be made to revolve in the lathe on which the attachment is placed.

The driving shaft of the attachment is supported by an adjustable bearing made to suit any make of lathe, and it passes through the driving box of the attachment which is bolted or clamped on the V's of the lathe carriage. A worm and worm wheel in this driving box transfer the power to a splined shaft above. At the end of the splined shaft is an adjustable graduated cross bar which acts as a crank to move a crosshead for any stroke required within a range of 1½ to 6 inches.

This crosshead carries the cutter bar which travels back and forth in a support bolted on top of the compound rest of the lathe. The bar can be raised or lowered to suit the center line of various swing lathes and is provided with a double-pointed cutting tool in order to groove consecutively on opposite sides of the bearing or shaft hole.

The cutting tool can be brought to any position while the lathe is in motion and it cuts grooves single or double figure eight without rechucking the piece. Taper holes or shafts are grooved by swiveling the compound rest slide, as the sliding block in the crosshead has a ball and socket bearing. The lathe spindle makes two revolutions to one complete stroke of the tool on the cutter bar.

A chain drive is regularly furnished, as shown in the illustration herewith, with the sprocket gear placed on the nose of the lathe spindle before the chuck is attached. The chain on this sprocket gear connects with a sprocket pinion fastened on the splined driving shaft. When attached to a Mueller lathe the driving shaft of the attachment enters into the lathe head through the hole shown in the headstock casting directly below the back gear pinion. The end of this drive shaft meshes with the face gear on the lathe spindle by means of a rawhide pinion and thus provides a direct drive for the attachment.



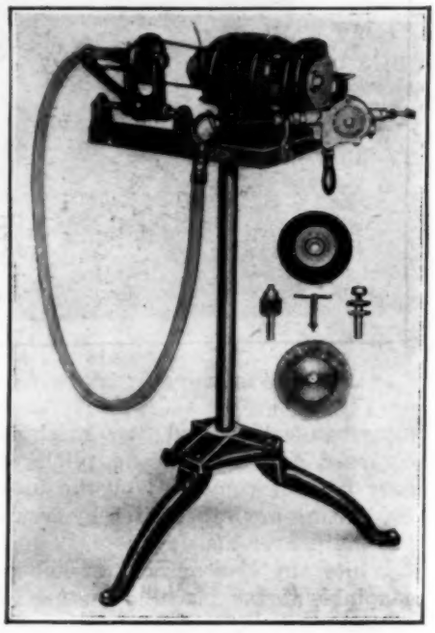
MUELLER OIL-GROOVING ATTACHMENT

Sioux No. 802 Flexible Shaft and Attachments

The accompanying illustration shows a motor-driven flexible shaft recently developed by Albertson & Co., Sioux City, Iowa, which is adapted for a number of uses such as valve grinding, carbon cleaning, tool and small part grinding and drilling. It is known as the Sioux No. 802 flexible shaft and in conjunction with its attachments is intended especially for repair shops and service stations.

A ¼-hp. a.c. motor provides the power to the shaft. This shaft has a universal joint and spindle control and is made of strands of piano wire, wound compactly one on top of the other, with small wire inside and larger wire outside. A feature of the shaft that is claimed to give it more life, is the use of roller bearings about 6 in. apart throughout its length. They prevent contact of shaft and housing when bent. The device is started and stopped by a clutch and has a variable speed obtained by means of a 3-step cone pulley.

The attachments which make the shaft adaptable to a number of uses include a 6-in. abrasive wheel; a 4-in.



SIOUX NO. 802 FLEXIBLE SHAFT ATTACHMENTS

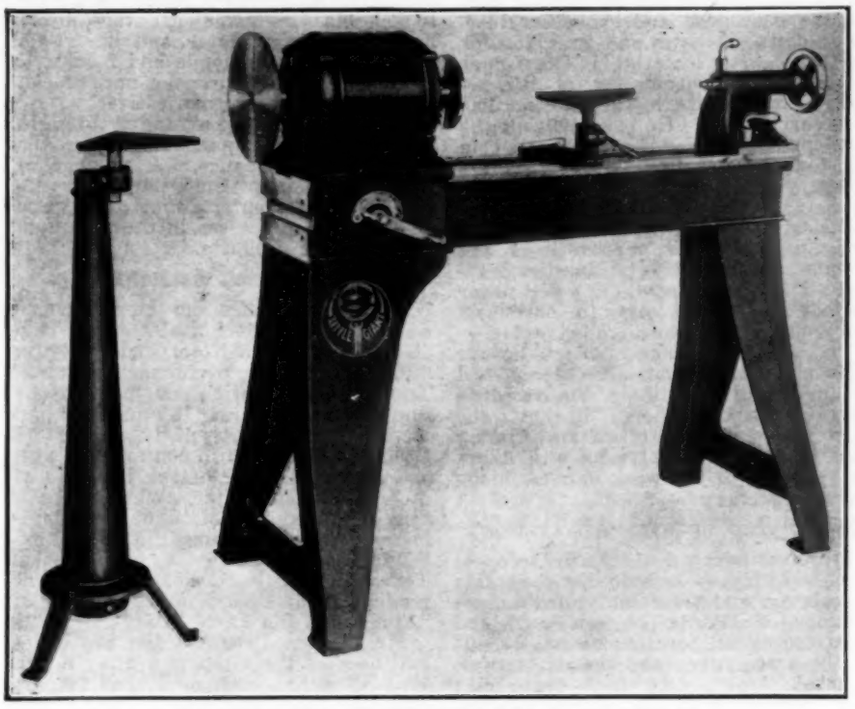
abrasive wheel and arbor; a 4-in. wire brush and arbor; a ¼-in. Jacobs chuck with arbor; and a valve grinding attachment. A vertical carbon cleaning wire brush with arbor may also be furnished.

The 6-in. wheel is permanently attached to the motor for grinding tools and other small parts. It is equipped with a guard and toolrest. The wire brush attachment is intended for removing carbon from cylinders while the chuck can be used to hold reamers, polishing devices and drills. The latter attachment is adapted when working in unhandy positions and lends itself readily in installing such accessories as signal lights and mirrors. The grinding attachment is similar to a manually operated grinding attachment. The variable speed that may be obtained enables the operator to use high speed on small valves and low speed on large valves, and the control feature enables him to lay down the device without shutting off the power.

"Little Giant" Headstock Motor Lathe

The Little Giant Co., Mankato, Minn., has recently developed the headstock motor lathe shown in the accompanying illustration which swings over the bed and tool rest 12 and 10 in. respectively. The machine occupies a floor space of 24 x 50 in., and has an overall height of 48½ inches.

A ½ hp. motor equipped with ball bearings supplies the power. This motor has four speed variations ranging from 570 to 3,450 r.p.m. which are selected by shifting the control lever that is located at the side of the lathe directly beneath the headstock and motor. A safety fuse box is furnished to prevent damage to the motor by overloading.



"LITTLE GIANT" HEADSTOCK MOTOR LATHE

The standard bed is 48 in. in length, 7 in. in width, 6¾ in. in depth and stands 36 in. from the floor. The distance between centers is 25 in. Beds of greater size can be furnished.

The headstock of the machine has a base 13½ in. in length, 10¼ in. in width and an overall height of 11½ in. An alloy-steel spindle is provided which is 17½ in. long, 1½ in. in diameter and has a ¾ in. hole through the center. Two face plates are furnished, one in front and one in the rear, respectively 6 and 10 in. in diameter. The latter is capable of handling work up to 80 in. in diameter. A No. 2 Morse taper hole is employed.

The tailstock, which has a base 7 x 7 in. and a height of 8 in. is clamped to the bed by means of a hand lever. It is furnished with a setover device for taper work and has a spindle which is 7⅛ in. in length, 1¼ in. in diameter and has a travel of 4 inches.

A hand feed carriage with cross feed and rest is furnished together with an automatic feed carriage, driven by a lead screw from the rear end of the headstock spindle, and which has all combinations ranging from $\frac{1}{16}$ to ½ in. The hand and compound swivel tool rests are interchangeable.

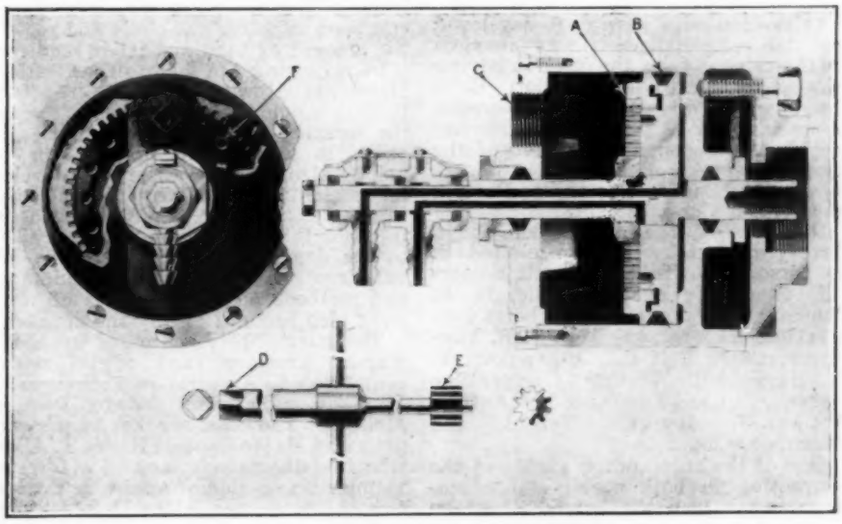
Other attachments which may be fitted to the machine include a band saw, saw table, jointer, planer, morticer, sander and buffer for wood working operations. The attachments are quickly and easily installed.

M.E.C. Style-H Air Cylinder

Changes have been made in the design of the M.E.C. air cylinder, which is a product of the Manufacturers' Equipment Co., Waller Ave. and Fillmore St., Chicago, Ill. The construction permits adjustments to be made without dismantling the cylinder, in order to prevent air leaks around the piston. The recently developed features are included in the Style-H cylinder, which has just been placed on the market, although they are applicable to other air cylinders manufactured by this company.

The improvement, as can be seen by referring to the accompanying illustration, consists of an internal ring gear *A*, which is threaded to screw on a shoulder on the piston, a V-shaped gap being left for the packing *B*. The plug *C* is removed with the aid of the square end of the wrench *D*, leaving a hole through which the pinion *E* is inserted.

The teeth of the pinion are then meshed with the teeth of the gear just enough so that the piston can be turned to bring one of the eighteen holes *F* in line to receive the pilot on the end of the pinion. The pinion is now pushed all the way in and turned to the right, turning the ring gear and screwing it onto the piston, which action compresses the packing. A special grade of V-shaped packing is used, which is guaranteed to give normal service for two years. Both wrench and ring gear are made of steel on this improved air cylinder.



M.E.C. STYLE-H AIR CYLINDER

News Section

Foundrymen Hold Big Convention and Exhibition

Cleveland meeting most successful yet—Exhibit very complete and interesting—Valuable material presented in papers—The industry shows both advancement and activity

WHAT WAS declared to be the most successful of the meetings of the American Foundrymen's Association, Inc., was held in Cleveland from April 30 to May 3. It was the twenty-seventh annual meeting of the association, and in conjunction with it was held the seventeenth annual exhibit of machinery and equipment for foundry use.

The meeting reflected the activity and growth of the foundry industry. The improvement of machinery and methods is materially changing the practice and enabling an increased amount of production, but at lower cost. The tendency is evidently toward lightening work in the foundry and decreasing the amount of labor required.

The exhibit of machinery crowded both the arena and the exhibition hall of Cleveland's new Public Auditorium. It opened on Saturday April 28 and continued through May 3. There was great variety in the types of machines, equipment and supplies shown, as all fields relating to the foundry industry were represented. There were many large working exhibits of molding machines, sand cutters, conveying equipment and the like, that gave the hall the aspect of an actual production shop. Makers of pneumatically operated tools, and small bench and hand tools were especially well represented. The great majority of the two-hundred-odd exhibitors were showing new developments. A feeling of satisfaction was prevalent among the exhibitors as to the success of the show, both in points of attendance and of the amount of business transacted.

Election of Officers

At the business session it developed that the administration was changed for the coming year, the election having been performed by letter ballot. C. R. Messinger of Milwaukee was succeeded as president by G. H. Clamer, first vice-president and general manager of the Ajax Metal Co., Philadelphia. H. B. Swan of the Cadillac Motor Co., Detroit, was elected vice-president.

Directors of the Association for a three-year term were also elected in the persons of Alfred E. Howell, Somerville Stove Works, Somerville, N. J., Thomas W. Pangborn, Pangborn Corporation, Hagerstown, Md., C. R. Messinger, Chain Belt Co., Milwaukee; T. S. Hammond, Whiting Corporation, Harvey, Ill.; and Lawrence Lee Anthes, Anthes Foundry Co., Toronto and Winnipeg, Can.

One of the outstanding events of the convention in both social and educational ways was the banquet held on Wednesday evening. At this meeting the retiring president, C. R. Messinger, review the work of the association during the past year and spoke interestingly of its activities and its plans for the future. Particularly, Mr. Messinger recommended continuation of the research work that the association has been carrying on. He believed that the developments which have occurred in the foundry industry within the last fifteen years are merely an indication of the activity which is to follow. One of his statements was, "The basis for our development is the work of the chemist, the metallurgist and the engineer; and the association must never neglect an opportunity to carry on research work of the highest order."

The president spoke of the generous gifts made by industrial concerns and by individuals to aid in the research work that is being done. It shows the generous spirit of co-operation existing throughout the industry as well as an appreciation of the work carried on by research men.

Co-operation between Associations

Mr. Messinger asked that the co-operation which has existed between this association and the foundrymen's associations of Europe be continued and even increased, for the mutual benefit of the associations and the industry in general.

It developed in the course of Mr. Messinger's address that more prizes for work of outstanding importance will be given through the association. This year the only one awarded was the Obermayer prize, which a committee passing upon the ideas and devices submitted presented to H. A. Mackie and Charles Parsons of Lead, S. D. The idea of the winning method is in making 12-in. chilled mine car wheels so as to eliminate handling the chills and reduce the amount of sand and labor required.

In reviewing the labor situation, Mr. Messinger drew attention to the fact that it would be necessary to better the working conditions in foundries in order to attract the proper type of help. Also, it is necessary to develop labor saving machines to an even greater extent than is now being done, in order that production may be raised to the demands of industry. The advantages of standardizing equipment and methods on certain types of work were also brought out by the speaker.

The guests were addressed by Emile Ramas, president and official representative of l'Association Technique de Fonderie, of France, and by Douglas Malloch. The chief speaker of the evening was Major General Henry T. Allen, who told the foundrymen in a forceful manner his opinion of affairs in Europe. Gen. Allen arrived in the United States only very recently, and with his staff, was the last of the American army of occupation to leave the foreign soil. He is recognized as a soldier, author, diplomat and administrator and his views relating to the economic and industrial conditions of the European nations can be considered as authoritative.

Social events were arranged throughout the meeting, particularly for the women in attendance. A number of industrial plants made particular arrangements for entertaining guests and showing the processes in the manufacture of their products.

Technical Sessions

Both the mornings and the afternoons were devoted to technical sessions held at the Hollenden Hotel and covering different branches of foundry practice. The opening session on non-ferrous foundry work relating to aluminum and its alloys was particularly interesting because it was held in conjunction with the Spring Meeting of the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers. At this meeting the annual exchange paper from the Association Technique de Fonderie, France, was read by R. de Fleury on the subject of "Aluminum and Light Alloys."

Mr. Fleury discussed the properties and uses of the aluminum alloy alpax. This alloy has been developed for automotive parts particularly, being used for cylinders, pistons and connecting rods. It is an alloy of aluminum and silicon, which when treated with certain alkaline salts is said to have unusual physical properties.

"The Linear Contraction and Shrinkage of Some Aluminum Alloys" was the subject of the paper by R. J. Anderson of the Bureau of Mines, Pittsburgh, Pa. The paper was the result of a series of experiments carried out at the Bureau of Mines with the idea of obtaining data to be used in making pattern allowances. The linear contraction was found to vary between 0.95 and 1.80 per cent. The effects of various factors upon the contraction of definite alloys was discussed and considerable valuable data on the subject presented.

"Density of Magnesium from 20 to 780 Deg. C." was the subject of the paper by J. D. Edwards and C. S. Taylor, Aluminum Company of America, New Kensington, Pa.

W. A. Mills, Alloy Foundry and Machine Corporation, New Rochelle, N. Y., spoke on the casting of aluminum radiator shells.

At the second non-ferrous session notes on the proper melting and pouring of brass and bronze were given by F. L. Wolf and Wm. Romanoff, Ohio Brass Co., Mansfield, Ohio. The authors discussed various shop problems encountered in making castings of brass and bronze, and gave data on pouring

temperatures, furnaces, properties of castings, fluxes and the like. It was concluded that the pouring temperature should be as low as possible, consistent with the sizes of the castings.

The method of casting bronze tablets in a commercial foundry was described by Jacob G. Kasjens, Brass Foundry Co., Peoria, Ill. Robert J. Anderson, Bureau of Mines, Pittsburgh, and Everett G. Fahlman, National Smelting Co., Cleveland, gave more data on the linear contraction of brasses and bronzes as determined in the experimental work being performed by the Bureau of Mines. In general, high temperature pouring causes less contraction than low temperature pouring. A paper was delivered by F. L. Wolf, Ohio Brass Co., Mansfield, Ohio, on "Briquetting Brass Turnings," and one on the "Effect of Heat Treatment on Release of Stress in Bronze Castings" by R. J. Anderson, Bureau of Mines, Pittsburgh, and C. L. Eldridge, Metropolitan Museum of Arts, New York City.

Steel Foundry Practice

The problems encountered in steel foundries were discussed at two sessions. In the first one M. W. Caruthers of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., spoke on the operation of basic electric furnaces. "The Production of Light Steel Castings for Ordnance Work" was the subject of Major Minton, U. S. Ordnance Dept., Watertown, Mass., who described the practice in use in the government arsenal there. A. D. Williams, Cleveland, spoke on the "Heat Generation in Open Hearth Practice," discussing fuels and their advantages for various uses.

By means of motion pictures, William McConway, of McConway & Torley, Pittsburgh, showed a process for the centrifugal casting of steel as being at present carried out commercially. The committee on specifications for steel castings presented through its chairman A. H. Jameson, Plainfield, N. J., a report of its activities and recommendations.

The fact that the heat treatment of steel castings emphasizes the good and bad qualities of the original casting was brought out in the second session on steel foundry practice by A. W. Lorenz, Bucyrus Company, South Milwaukee, Wis. The speaker talked of heat treatment practice on chrome-nickel steel castings and recommended further research on special alloy steels.

"Annealing Steel Castings" was the subject of a paper by H. A. Neel, Michigan Steel Casting Co., Detroit, who told of investigation work to determine the proper heat treatment to apply to electric steel castings. C. S. Koch, Fort Pitt Steel Casting Co., McKeesport, Pa., spoke on "Core Mixtures for Light Steel Castings." In this session committee reports were received on refractories and on the heat treatment of ferrous castings.

A great deal of attention was given to the subject of sand research work. At the first session on sand a report of a joint committee of the A.F.A. and of the National Research Council Molding Sand Investigation was received. Standard tests and specifications of sand were recommended, among other things.

Dr. H. Ries and C. M. Nevin, Cornell University, Ithaca, N. Y., presented a paper telling of tests of cohesiveness of foundry sands. A method of testing based on that previously developed by R. J. Doty has been perfected and used in the tests with considerable success. Eugene W. Smith of the Crane Co., Chicago, also told of physical tests for foundry sand, his test being a simple one used for daily checking the fitness of sand for various classes of casting.

"Sand Conservation and Reclamation Tests Using the Doty Testing Machine" was a paper presented by R. F. Harrington, W. L. MacComb and M. A. Hosmer, Hunt-Spiller Mfg. Corp., Boston, Mass. The authors gave a general survey of the problem of sand conservation and reclamation and then took up the effects of moisture, grain size, mulling and such factors on the bond of the sand. H. W. Highriter, Commercial Laboratories, New Haven, told of the use of chemical reagents in the preparing and rebonding of molding sands, and also of the effects of certain acids and alkalies in bringing out desired qualities of the sand.

"The Application of Fuel Oil to the Malleable Air Furnace" was described by A. V. Landschoot, Iowa Malleable Iron Co., Fairfield, Iowa. The system which he discussed has been in successful operation for some time, due to the proper working out of details. It was shown by E. K. Smith, Lakeside Malleable Co., Racine, Wis., that there are great possibilities in hardened and tempered malleable castings. It is desired to obtain castings having better properties than those ordinarily made, although the experiments were not carried through to a conclusion to show just how this could be done commercially.

Philip Dressler, American Dressler Tunnel Kilns, Inc., Cleveland, gave a talk on the adaption of continuous muffle annealing furnaces to the malleable iron industry. Details as to the construction and operation of the furnace were carefully worked out. S. J. Felton, Ohio Mechanics Institute, Cincinnati, spoke upon methods employed for the melting of malleable cast iron in small furnaces. E. D. Halsey, Terre Haute Malleable & Manufacturing Co., Terre Haute, Ind., described a method in use at his plant to reduce the amount of scrap in a malleable foundry, and a report was given by the committee on specifications for malleable castings.

Gray Iron Session

Under the title of "Notes on Gray Iron for Automotive Casting," H. B. Swan, Cadillac Motor Car Co., Detroit, told of foundry practice as determined by the results of a questionnaire sent to a number of automotive casting plants. Mixtures, cupola practice and such points were taken up. "Carbon in Cast Iron" was discussed by A. W. Bolton, Niles Tool Works, Hamilton, Ohio, and the "Visual Observation of Melting in a Cupola" by John Grennan, University of Michigan, Ann Arbor.

A number of miscellaneous topics were taken up. G. K. Elliott of the Lunkenheimer Co., Cincinnati, spoke on "Gray Cast Iron from the Point of View of the Electric Furnace." L. F. Barton of Diebert, Bancroft & Ross, Ltd., New Orleans, had for his subject "Electric Furnaces from the Manager's Viewpoint." It was shown that the electric furnace was an economical proposition for the production of iron castings. "The Manufacture of Synthetic Foundry Iron in the Electric Furnace" was presented by C. E. Sims, C. E. Williams and B. M. Larsen, Northwest Experiment Station, U. S. Bureau of Mines, Seattle. It was stated that tests showed that 4 per cent of carbon could be introduced without difficulty. D. B. Stokes of the United States Cast Iron Pipe and Foundry Co., Chicago, told of the manufacture of cast iron pipe.

Some interesting new developments were brought up at the convention. "Centrifugal Casting of Iron Piston Rings" was discussed by John A. Rathbone, Detroit, and "Centrifugal Casting" in general by Leon Cammen, New York City. Dr. Richard Moldenke, Watchung, N. J., delivered two papers, one on the "Desulphurization of Cast Iron" and the other on "A New Long Life Mold Development," both papers showing original thought.

Problems of Labor

Dr. Percy Longmuir, Sheffield, England, presented the annual exchange paper from the Institution of British Foundrymen, under the title of "British Foundry Practice, Ferrous and Non-Ferrous." Dr. Longmuir summarized the outstanding recent developments in British foundry practice, and showed how the growing use of scientific methods is making the British foundrymen more efficient than formerly.

The problems relating to labor and the training of foundry workers were thoroughly discussed at one of the sessions by a group of men whose work when combined formed a valuable symposium on the subject. Continuation schools, extension courses and shop training were discussed, and the concensus of opinion was that the successful apprentice course must be based upon a policy to give thorough training to the apprentice and at the same time afford sufficient monetary reward during the period of apprenticeship. It was realized that the hard labor generally connected with foundry work was apt to discourage boys from entering as foundry apprentices, and that it was necessary both to reduce this amount of labor and to provide the best working conditions possible. The speakers at the session were: W. F. Simon, Apprentice Division, Industrial Commission of Wisconsin, Madison; L. A. Hartley, Nebraska Dept. of Vocational Education, Lincoln; C. M. Morrin, Brown & Sharpe Mfg. Co., Providence; A. B. Mays, University of Illinois, Urbana; J. Grennan, University of Michigan, Ann Arbor; A. L. Williston, Wentworth Institute, Boston; L. W. Klein, Coxe Traveling Grate Co., Port Carbon, Pa.; H. A. Frommelt, Falk Corp., Milwaukee; O. W. Potter, University of Minnesota, Minneapolis; F. W. Kirby, Deere & Co., East Moline, Ill.; E. A. Parker, Springfield Aluminum Plate & Casting Co., Springfield, Ohio.

Los Angeles Regional Meeting Held

More than two hundred people attended the first Pacific Coast Regional Meeting of the A.S.M.E. in Los Angeles, April 16-18. An interesting feature of the meeting was the inspection of the Pickford-Fairbanks Studio in Hollywood. The trip to the summit of Mt. Wilson was well attended. Prof. Francis G. Pease, astronomer in charge of design at the Mt. Wilson Observatory, gave demonstrations and lectures on the use of the instruments.

Eastern Railroads in the Machinery Market

A lull, not unexpected but nevertheless unwelcomed, has been noted in the market for all kinds of machinery and machine tools in the New York City district. While industries are still working at or near capacity on orders that have been received in the past and there is every indication that the prosperous conditions will continue, new orders have not come in with the same speed that was shown during the first three months of the year.

Railroads are buying steadily and both the Erie and the New York Central have recently placed big orders, the former for its new shops at Hornell and the latter for all of its shops in the East. Inquiries have also been received from all Eastern roads.

Garage machinery and small tools have been in demand during April and it is reported that welding apparatus is selling exceptionally well.

Used machinery is being sought in the South and some parts of New England and sold at reasonable prices, due to the fact that replacements by large manufacturing plants have increased the supply of used machines.

It is the consensus of opinion of the dealers in the Metropolitan section that business will be good for the next six months and the present quietness is merely temporary.

Auto Parts Companies in New Merger

Stock of the Eaton Axle and Spring Co., is being offered subject to approval by stockholders of the Torbenson Axle Co., as a step in financing the consolidation of three automobile parts manufacturers, including besides the Torbenson Co., the Eaton Axle Co. and the Perfection Spring Co., with principal plants and offices at Cleveland. The offering consists of 140,000 shares of no par value capital stock at $30 a share.

The Eaton Axle and Spring Co. is now the Torbenson Co., which has been the principal mover in the merger. Stockholders of the Torbenson Co. have been asked to approve an increase in capitalization from 80,000 to 220,000 shares and have also been asked to consent to the change of name to the Eaton Axle and Spring Co. The stock is being underwritten by New York and Cleveland brokers.

Sales in Chicago Still Satisfactory

Numerous concerns in the machine tool and small tool industry in the Chicago District report no decrease in the number of orders received during the month of April, but an approximate decrease of twenty-five per cent in the value and volume of sales. This is accounted for by a tendency of industry to be uncertain as to the future of business as to volume and conservatism in buying. The big exception is the railroads. The Illinois Central and the St. Paul have recently placed rather large orders for small tools. The Santa Fe Railroad has made inquiry for lathes, grinding machines, shapers, presses for car wheels and miscellaneous equipment.

Inquiry for iron is less active, although sales are being made of small tonnages to balance stocks from day to day. Production is heavy in the Chicago District and is increasing slightly. Warehouse steel is in good demand for building operations and general manufacturing lines. Stocks are fairly well balanced and deliveries can be made within a reasonable length of time. Production of agricultural machinery in the United States during March was seasonably greater than that of both January and February. There was a gain of 37 per cent in sales over the two previous months according to the monthly review of the Chicago Federal Reserve Bank. Considerable of the present buying is attributed to deferred purchases which have accumulated during the last two years.

Committee of F. A. E. S. to Study Coal Storage

Appointment of four members of the committee to conduct an investigation of the storage of coal is announced by the Federated American Engineering Societies. They are: P. F. Walker, dean of engineering, University of Kansas; S. W. Parr, professor of applied chemistry, University of Illinois; H. Foster Bain, Director of the U. S. Bureau of Mines; L. E. Young, Union Light and Power Co., St. Louis. The chairman is W. L. Abbott, chief operating engineer of the Commonwealth Edison Co., Chicago.

Four or five additional members of this committee are yet to be selected. Consideration is being given to recommendations by member organizations, it is stated.

Buffalo Dealers Selling To Railroad Shops

Construction work in the Buffalo territory, which is the heaviest it has been in four years, is creating a splendid market for small concrete mixers, hoists, engines and other equipment of this nature. Coincidently, there is a brisk inquiry for replacement parts for construction and road machinery.

Small tools are in demand and distributors of this class of equipment report that many manufacturers are buying small equipment and adapting it to their needs in place of certain types of larger equipment on account of the scarcity of labor.

Labor costs are higher than usual at this time of the year and competition for skilled workers is keen in all industries.

There seems to be no falling off in the demand for the heavier types of equipment. Railroads in the Buffalo territory are buying considerable equipment, including electric traveling cranes, pit cranes, and heavy lathes. Lathes of all types, drilling machines, grinding machines and shapers are showing an activity far ahead of last year.

The Buffalo Creek Railroad recently installed a complete machine shop equipment consisting of grinding machines, lathes, shapers and small tools. The D. L. & W. Railroad has installed a shaper and two geared head lathes in its East Buffalo shops. The New York Central shop has bought two heavy double axle lathes. Brass goods, including safety valves, gages and locomotive injectors are being bought.

Farrell Urges Co-Operation with Shipping Board at Foreign Trade Council

Addresses by James A. Farrell, president of the United States Steel Corp., on "The Shipping Situation of the World," and C. H. Markham, president of the Illinois Central Railroad, on "Railway Service for Foreign Trade," were features of the closing general session of the tenth annual convention of the National Foreign Trade Council.

Loss in operation of American ships comes not from a surplus of modern ships, but from a lack of co-operation on the part of all owners, foreign and domestic, to stabilize a business in which all are suffering, according to Mr. Farrell.

"I am confident our foreign rivals would recognize the desirability of co-operation by all maritime countries in disposing of tonnage to be used in the market, so as to balance the supply of ships with the demand, thereby stabilizing rates, not merely to the advantage of the operators, but even more to the advantage of the traders of the world," he said.

"There is an opportunity for a trading relation. The Shipping Board admittedly has many more ships than it hopes or needs to sell to Americans. Retain sufficient for our needs and sell to foreigners the surplus. Internationally, there can be built a basis for the sale of the board's ships at the world's market price in a manner which will give to the American shipowners a paying basis on the volume of trade they seek. The board would be in a position to say to the American company in a given trade route:

"'Co-operate with the foreign lines now competing with you; furnish one-half of the tonnage required to move the freight over a particular route; each to act as loading and discharging agent for the other; each plan which ships of the two companies will operate on an alternate schedule, and thus each will receive an equal portion of the business moving in both directions.'

The Foreign Competition

"The foreign line would receive the advantage of replacing obsolete ships with modern ships at a fair price; they would know within reason the elements with which they and their American partner would have to contend; they would know that they would no longer have to match their reserves against those of the United States Treasury; and, best of all, the available ships would be leveled down to the number the world trade requires, through scrapping such of the Shipping Board fleet as is obsolete and the scrapping of such foreign tonnage as is in a similar condition."

Mr. Farrell declared that, while one-third of the Government-owned ships would not justify the cost of reconditioning, at least two-thirds could be put into commission at a cost not exceeding $5 per ton, dead weight, and at least half of it could ultimately be sold to foreign buyers at from $10 to $15 a ton less than the price at which foreigners could now build similar vessels. He suggested a selling charge of $35 per ton, dead weight.

Philadelphia Industries Well Employed

There was nothing to indicate to Philadelphia manufacturers and jobbers any recession in the volume of business that has been reported good during the spring. Reports from the trade indicate a demand for used traveling cranes, with orders booked for a year ahead.

Conveying and hoisting equipment is in active request, with orders and inquiries showing a marked improvement over this period a year ago. Many power stations are being improved by the installation of this equipment, and a demand is coming from mills and mines.

Due to the vast amount of building, elevator sales have increased twenty-five per cent over last year. Deliveries are fairly prompt and manufacturers are looking forward to a further increase in the volume.

Calculating machine sales have increased fifty per cent over last year, with a tendency toward the adding and listing machines, while bookkeeping machines are selling fairly well.

In the woodworking machinery line manufacturers and dealers report a satisfactory situation. Without any effort to obtain new business firms here have orders enough ahead to keep them going at least until August.

The Harlan plant of the Bethlehem Steel Co. at Wilmington, Del., has begun the delivery of 100 new suburban steel coaches and fifty standard steel coaches for the Philadelphia & Reading Railway. The Baldwin Locomotive Works has contracts for fifty-five locomotives, fifty of the consolidated freight type and five switch engines. Ten passenger engines are being built at the company's shops at Reading, Pa., and a number of baggage cars are being constructed.

Milwaukee Business Is Still Strong

Casting up accounts, Milwaukee machinery manufacturers have found that April sales and bookings showed a healthy increase over the same month last year, thus continuing in effect similar increases recorded in January, February and March. In the first week of May, the quality and quantity of business has been equally as gratifying, and every confidence is held that the current month's sales will show a further continuance of the increases.

Basing expectations on inquiry and sales, as well as the continued improvement of demands upon foundries and machine shops, a comparatively large amount of tool business lies before the trade. The betterment in demand is particularly noticeable in the milling machine industry, which has been trailing other classes of machine tools in making headway since the revival of the metalworking industries set in. Makers of milling machines say trade is still spotted and more or less irregular, but volume is becoming noticeable and their hopes for the remainder of the year are more optimistic than they have been for a long time past.

The growing tendency among bankers to warn against inflation to avoid the disastrous results of artificial prosperity as known in 1920 meets with a hearty reception, especially among manufacturers of machine shop equipment. Likewise, it appears to coincide closely with the opinions they have held since the recovery from depression began. While this may have meant sacrifices and may mean further sacrifices, it is believed preferable to have the improvement in business gradual, but substantial, rather than rapid and artificial.

The lack of any substantial improvement in export trade, especially with Europe, necessarily limits business largely to domestic needs, although some sales are being made off and on to Japan, Australia and South America.

Used tools remain a formidable competitor in domestic markets, and the surplus of this class of equipment continues more or less stationary, for present or past financial difficulties of manufacturing concerns manage to keep fresh lots of used equipment flowing into trade channels. There is, however, a fair demand for choice used machinery of modern design and usefulness.

The demand for new equipment remains well confined to bare necessities, for replacements and moderate increases in production capacity. The bulk of orders is for single machines, or a few tools, and virtually all orders specify prompt delivery. Future needs are not being anticipated, owing to the exercise of caution against over-expansion, which is a quite general policy.

Building Activity Aids St. Louis Trade

Despite the tremendous output of the last six weeks and the large shipments which have been made, machine shops, foundries and kindred industries in St. Louis are still working at full capacity and future orders have been booked which will warrant a continuation of this healthy condition for at least another six weeks to come. The railroads, automotive industries, oil and mining industries in the South and Southwest are the biggest purchasers. Building throughout this locality is at the highest peak it has reached in years.

As a barometer of business generally the railroad car loadings of one week showed an increase of 18,000 cars over the corresponding week of 1922, with ore one of the commodities showing the heaviest movement.

Virginia Railway Will Electrify Division

In order to increase its traffic capacity and to secure important operating economies, the Virginian Railway has decided to electrify 213 miles of its track lying between Roanoke, Virginia, and Mullens, West Virginia. This undertaking will involve the expenditure of $15,000,000. The order for the electric locomotives, power house, transformer stations, and other apparatus has been awarded to the Westinghouse Electric & Manufacturing Co. of East Pittsburgh, Pa., and forms the largest railroad electrification contract ever placed. The division to be electrified crosses the Allegheny Mountains. The alternating-current, single-phase system will be used.

Skilled Workers Needed In Pittsburgh

There are no pessimistic reports coming from Pittsburgh regarding the machine tool trade, or any other part of the machine industry, for with the steel mills humming the way they are, the prosperity of the machine business is but a reflection of the general status throughout the iron and steel industry. Dealers in machine tools in the Pittsburgh district are watching the trend of the steel market very closely, and the recent price advances in sheets, tin plate, tubular goods, sheet bars, shapes and plates, is figured to be a help to the keeping up of price in machinery of every description.

The dealers report a general inquiry for machine tools for early delivery, especially on the part of the large manufacturing establishments, while it is expected that a number of railroad orders will shortly be placed that will give quite an impetus to the machine tool trade. Inquiry among the factories of the Beaver Valley elicits the information that all the machine shops connected with the steel mills are working night and day, while the machinery parts of the railroad repair shops seem to be well filled with orders, and every man who can use an expert hand at a machine is employed. Skilled men are badly needed in this district, not only in the steel mills and machine shops, but in almost every part of the building trade. There are a few transients who pass through here and accept a job for a few weeks and then amble along elsewhere, but the wages being offered by machine tool makers now is alluring enough to hold their steady men, one employer of a large number of men saying a few days ago that he had no fear of filling his contracts and making deliveries at the time promised so long as his old-timers remain on the job. Auto repair shops and garages are springing up like mushrooms through the night, and many splendid orders along the line of machine tools are being placed with the local dealers. Manufacturing plants are being operated at almost capacity, and while the machine tool business has not reached its peak in this district it is better than ever before in industrial history.

American Catalogs Wanted In Brazil

W. L. Schurz, American commercial attaché at Rio de Janeiro, Brazil, advises that he is desirous of receiving catalogs of machinery of all kinds that might be of interest in Brazil. Catalogs should be mailed to the Industrial Machinery Division, Bureau of Foreign and Domestic Commerce, Washington, D. C., and should be marked on the outside front cover: "To be forwarded to W. L. Schurz, American Commercial Attaché, Rio de Janeiro, Brazill."

Manufacturers who have agents in Brazil should indicate their names and addresses on the printed matter. It would be well to furnish more than one set of printed matter, as it frequently is desirable to have extra copies to give to interested inquirers. The language employed in Brazil is Portuguese; if printed matter is not available in that language, French would be preferable to Spanish.

News of Washington Activities

BY PAUL WOOTON

Export achievements in which the Industrial Machinery Division of the Department of Commerce takes particular pride are being listed. Some of them are as follows:

The Saco-Lowell Shops, of Boston, in the face of very active British competition, secured an important order for machinery to be used in the handling of spun silk.

The Baldwin Locomotive Works recently sold 25 locomotives to the British Government. Ten of these locomotives were discharged from the steamer at Danzig in 57 hours. Not only was a large order for locomotives filled rapidly, but an American vessel was able to handle the cargo and discharge it in record time, despite the fact that some of the packages weighed thirty tons.

American manufacturers furnish the most efficient coal and ore-handling machinery in use at Rotterdam. The same equipment, with a change of buckets, is used for loading coal and for unloading iron ore.

Twelve electrically driven ore excavators recently were installed at the Schneider mine, the property of the greatest of the French steel makers.

From time to time as such striking incidents of machinery sales are recordeed, the Department of Commerce expects to give them publicity, particularly in foreign countries, with the idea of indicating that American manufacturers are selling their machinery in the greatest centers of competition and to the most discriminating buyers.

KIND WORDS FROM BRITAIN

That the competition of American machinery in India is beginning to be felt may be judged from the following extract in the report of a British official:

"Indian buyers, owing to our enforced activity during the war, are now looking more and more to the United States to supply their requirements and are in some cases apt to imagine that America leads the world in machinery production—an erroneous idea which the American engineer and traveling salesmen are only too anxious to foster."

While American metal-working machinery is being furnished in increasing quantities to purchasers in India, the use of machinery in that country continues to be subject to certain limitations because of the superstitions of the natives. Many of the operations done by machinery appeal to the Hindoo as being uncanny. There is a widespread and apparently firmly held belief that certain machinery, at least, is possessed of a bad spirit. This leads to widespread refusal to accept employment where the handling of machinery is a requirement.

Dr. H. C. Dickinson, formerly head of the Automotive Power Plants Section of the Bureau of Standards, has returned to that Bureau as chief of the Heat Division, assuming his duties May 2. Since 1921, when he resigned from the Bureau, Dr. Dickinson has been research manager of the Society of Automotive Engineers.

Dr. Dickinson is a native of Bangor, Maine, where he was born in 1875. He is a graduate of Williams College, and did graduate work at Clark University where he took his doctor's degree. He was with the Bureau of Standards from 1903 to 1921, starting as a laboratory assistant and being advanced to the position of physicist in 1910. He is a member of the American Academy, American Physical Society, American Society of Mechanical Engineers, American Society for Testing Materials, Society of Automotive Engineers, Society of Refrigeration Engineers, Washington Academy, Washington Philosophical Society, and the Society of Physique.

In his former connection with the Bureau of Standards, Dr. Dickinson was responsible during the war for the construction of the altitude chambers in which airplane engines can be tested under the conditions of low air pressure and temperature corresponding to altitudes of 30,000 feet. He was scientific adviser to the government in connection with the utilization of the nation's gasoline supplies and had much to do with the efficient utilization of these supplies.

Comparative Prices of Shop Supplies

Average of New York, Chicago and Cleveland Prices

	Unit	Current Price	Four Weeks Ago	One Year Ago
Soft steel bars..	per lb.....	$0.034	$0.0322	$0.0236
Cold finished shafting.....	per lb.....	0.042	0.0406	0.032
Brass rods.....	per lb.....	0.1913	0.1913	0.15
Solder (½ and ½)	per lb.....	0.2987	0.314	0.21
Cotton waste..	per lb.....	0.1231	0.1231	0.104
Washers, cast iron (½ in.)...	per 100 lb.	4.66	4.50	4.00
Emery, disks, cloth, No. 1, 6 in. dia.....	per 100.....	2.96	2.96	3.11
Lard cutting oil	per gal.....	0.592	0.575	0.608
Machine oil....	per gal.....	0.349	0.349	0.40
Belting, leather, medium.....	off list.....	42%	42%	48½%
Machine bolts up to 1 x 30 in.	off list.....	44¼%	48½%	62½%

R. P. Miller Reappointed To Awards Board

Rudolph P. Miller of New York has been reappointed representative of the Federated American Engineering Societies on the National Board for Jurisdictional Awards. Mr. Miller's reappointment was officially characterized as evidence of the Federation's confidence in what he has accomplished. His efforts, it was stated, have been "earnest and constructive." Mr. Miller's present term expires in August.

More Pay for Workers In Metal Trades

According to figures just compiled by the National Industrial Conference Board, wages in the metal trades increased appreciably during the month of February. The average hourly earnings of all wage earners in the agricultural implement plants studied were $0.507 in February as against $0.503 in January and $0.499 in December. In the automobile shops they were $0.599, $0.598 and $0.594, respectively, while in the electrical manufacturing shops they were $0.519, $0.515 and $0.514. For iron and steel mills, average earnings were $0.540, $0.531 and $0.537, and for foundries and machine shops, $0.535, $0.527 and $0.530. For all industries the February figure was $0.509, January, $0.504 and December, $0.504.

Skilled labor in the foundries and machine shops earned $0.586 in February, $0.576 in January and $0.578 in December as against $0.632, $0.632 and $0.635 in the automobile shops and $0.577, $0.570 and $0.572 for all industries. Unskilled labor got $0.435, $0.429 and $0.436 in the foundries and machine shops in February, January and December, respectively, $0.471, $0.475 and $0.471 in the automobile shops and $0.416, $0.415 and $0.416 in all industries.

Weekly earnings of skilled men in all industries rose from $28.22 in December to $28.32 in January and $28.44 in February. In the foundry and machine shops the corresponding figures were $28.85, $28.59 and $29.21 and in the automobile plants $30.30, $31.13 and $31.19.

A slight decline in living costs brought "real" earnings up one point on the hourly basis and two points on the weekly basis.

Erie Sets Good Example By Storing Coal

In keeping with the program mapped out by the Association of Railway Executives at its meeting here last month the Erie Railroad Co. has been storing coal steadily, Frederick S. Underwood, president, said recently.

"We now have a supply of thirty-six days' coal on hand," Mr. Underwood said, "and by Sept. 1 will have stored up a supply for ninety days, or enough to take care of requirements during September, October and November. The Erie's shops have now brought the road's locomotive equipment up to normal, bad order locomotives averaging about 15 per cent of the total on line, and by Oct. 1 it is expected that freight cars awaiting repairs will be reduced to 5 per cent of the total on line."

Bliss Co. Moves Offices

The E. W. Bliss Co., Brooklyn, N. Y. has moved its offices, both sales and executive, to the South Brooklyn plant at Second Ave. and 53rd St. The plant has a total of seventeen buildings in the group.

The Business Barometer

This Week's Outlook in Commerce, Finance, Agriculture and Industry Based on Current Developments

By THEODORE H. PRICE
Editor, *Commerce and Finance*, New York

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NEARLY ALL the speculative markets were lower last week and the uneasy feeling which declining prices generally engender is gradually spreading. It is in part due to the fear that the buyers strike in sugar may be extended to include other articles, but it is also attributable to the fear that the Federal Reserve Banks may decide to adopt a policy that will in some way compel a restriction of credit. In their monthly bulletins the Federal Reserve Board and the New York Bank both quote the following passage from a recent report of a committee on "Unemployment and business cycles" appointed by Secretary Hoover: "Additions to credit which cannot be economically validated by a commensurate effect in actual production are speculative and as such should be subjected to control so that business and industry can be maintained in a healthy state."

The Federal Reserve Board prefaces this quotation with the statement that it "clearly sets forth the relation between the expansion of bank credit and the expansion of business as well as the responsibility of the banking community for the economic use of credit."

This declaration has been logically construed as an intimation that the power of the Federal Reserve System would be used to check any developments of which its officers did not approve and the fear that sumptuary control would be substituted for the operation of economic law has naturally engendered doubt and checked initiative.

Two months ago when caution was first advised in these letters there was a possibility that an unchecked advance in labor and commodities might produce a boom that would be followed by a destructive explosion, but in the interval merchants and manufacturers have themselves applied the brakes, and in a speech he made last week Frank Vanderlip was exactly right in saying that "Most people seem as cautious about the financial outlook as they would be toward a scarlet fever epidemic. Their point of view is understandable inasmuch as so many were hit by the seeming prosperity of three years ago. The present situation I consider decidedly different.

"In my opinion we are now in a far sounder economic phase. The banks' position in regard to expanded credit is far healthier and commodity prices are 35 per cent below those of three years ago. At that time buyers were loaded up in advance of their needs. Now just the reverse condition obtains. There is no accumulation; the situation is almost flawless. If I were to paint the picture in detail the only shadows would be along the shipping and agricultural lines."

It is, of course, possible that some unlooked for upheaval or a general crop failure may curtail the purchasing power of the country in the autumn, but barring improbable misfortunes a good business is indicated for the next four or five months, and that is about as far ahead as it is safe to look nowadays.

In the stock market, which is now from 15 to 20 points below the top on the average, there are many good bargains to be picked up. This is especially true of the railway shares, for railroad earnings continue to improve and a phenomenal gain will probably be shown when the new equipment recently ordered comes into use.

> "Two months ago when caution was first advised in these letters, there was a possibility that an unchecked advance in labor and commodities might produce a boom that would be followed by a destructive explosion, but in the interval merchants and manufacturers have themselves applied the brakes . . . In the steel industry, production continues at a record rate largely as a result of the demand from the railroads and automobile makers."

The decline in the price of petroleum and the reported war between the Standard Oil and the "Independents" has caused a sharp drop in the market for oil stocks. They too may be good purchase, but in so far as the so called "Standard Oil Companies" are concerned it should be borne in mind that the prices at which they are selling represent success plus prestige and that the generation who made "The Standard" what it is have for the most part passed on.

The bond market is now at a level which invites discriminating purchasers except in the tax exempt department, where an over supply threatens as a result of the constant issuance of Farm Loan Bonds, Road Bonds, Municipal Bonds and Soldiers Bonus bonds put out by the various states. Over $100,000,000 of these soldiers bonus bonds will shortly come on the market, including $50,000,000 from Illinois and $22,000,000 from Iowa. Illinois is also considering the sale of $100,000,000 road bonds, and if there is any element of danger in the present situation it is to be found in the flood of these tax exempt securities for the service of which a constant increase in taxation is necessary.

An interesting development is the proposal to consolidate several of the large fertilizer companies that have never entirely recovered from the heavy losses they sustained two years ago.

In the steel industry production continues at a record rate largely as a result of the demand from the railroads and the automobile makers. At 16¼ cents copper is off about 3 cents from the top, but the demand is unabated and the decline is chiefly due to the large production.

Lumber is a shade easier on the threatened curtailment in building caused by high wages. Sugar is off about half a cent on the buyers strike already mentioned. It is an interesting novelty, as is the attempt that the people of Memphis are making to "take care of their own" by buying the stock in the Piggly Wiggly Co. with which their fellow townsman, Mr. Saunders, was landed in his fight with the bears on the New York Stock Exchange.

If the women can hold down the price of sugar and Memphis can take care of Piggly Wiggly the legendary power of Wall Street may lose something of its terror. Cotton has been distinctly weak as those who might have tried to squeeze May and July have taken the hint that Attorney General Daugherty has given them in his suit to enjoin future trading in sugar. New crops are sympathetically lower, but are approaching the level of intrinsic value when the statistical facts and the crop outlook are considered.

The retail trade is good. The mail order houses report a continued and remarkable gain in sales and jobbers say that their orders are numerous but small as a spirit of caution is general and no one wants to carry a heavy stock. This spirit and a Federal Reserve statement which shows a reserve ratio of 75.2 per cent are our best guarantees that business is on an even keel and that the present depression being psychological will be short lived.

Germany's offer to settle her reparation liability by a payment of 30 billion gold marks or about $7,500,000,000 provided she can borrow the money hardly requires comment. It was made for sentimental effect and no one expected its acceptance. The probability is that France will continue to occupy the Ruhr and the Rhine provinces indefinitely. Most of Europe seems resigned to this and until England protests the *status quo* will probably be undisturbed.

Water Traffic for Big Steel Companies

What amounts to almost a new industry is the transportation of finished steel products down the Ohio and Mississippi rivers from Pittsburgh to New Orleans. The Carnegie Steel Co. and the Jones & Laughlin Steel Corp. are the pioneers in this enterprise. The former has two steamboats and 35 steel barges plying between this port and New Orleans, while the Jones & Laughlin concern is sending out about 8,000 tons a month to Louisville, Evansville, St. Louis and Memphis, for distribution throughout the south and west. In these cargoes are machines and machine tools of all descriptions and for various destinations.

Report on Production of Soft Coal

The production of soft coal continues at approximately 10,000,000 tons weekly, according to the Geological Survey, while the anthracite output, for the eighth consecutive week, exceeded 2,000,000 tons.

The total output of bituminous for the last week in April was estimated at 10,235,000 net tons. A declining production for the past week was indicated by car loadings.

Concerning the present reserve, the geological survey states that while stocks on March 1 were not at an extremely high point, yet they exceeded those in 1920 by 50 per cent and demand for coal has steadily fallen off. Complete records of consumption since February are not available, but it seems quite clear that if the rate of consumption in that month has been maintained, stocks are perceptibly lower than on March 1, the survey says.

"Well sustained activity marked the reports of anthracite shipments in the week ended April 28," it stated, "and for the eighth consecutive week excluding only the week of the eight-hour holiday, the output passed the two million ton mark." The total output was estimated at 2,116,000 net tons.

Simplified Practice to Be Discussed

A preliminary conference of manufacturers, distributors and consumers of face brick will be held May 11 with the Division of Simplified Practices of the Department of Commerce. The conference will discuss the advisibility and practicability of reducing the number of types and sizes.

Steel refractory interests will meet with the Division in preliminary conference May 21 to discuss possible simplification in this industry.

A general conference of paving asphalt interests will be held with the Division May 28 to consider definite action regarding reduction of grades and other simplifications which were discussed at a preliminary conference several weeks ago.

Will Discuss Paper Mill Problems

The problems met in the paper industry will be presented at two sessions at the Spring meeting of the American Society of Mechanical Engineers in Montreal, May 28 to 31. Robert B. Wolf, president of the R. B. Wolf Co. of New York, will outline "Principles of Management Engineering as Applied to the Pulp and Paper Industry" on May 29, and on May 31, George F. Williamson, chief engineer of the Strathmore Paper Co., will introduce a group of speakers who will discuss "The Machine Tool in the Paper Industry."

Pig Iron Production at New High Record

A new record rate was reached in pig iron production late in March, and that rate has since increased to 5 per cent above the old record, which was made in September, 1918. Pig iron production, according to the monthly blast furnace report, is now running at approximately 44,000,000 tons a year. Production in a calendar year has never reached 40,000,000 tons, and did not reach 31,000,000 tons until 1916, nor 26,000,000 tons until 1910.

Steel production is well maintained at the rate reached late in March, since which time ingot output has averaged a rate above 45,000,000 tons a year. The production of pig iron is relatively higher than the production of steel, which accounts for the easy position the pig iron market has been showing lately, as well as for the decline in scrap prices.

Will Discuss Many Topics at Annual Meeting

A broad range of thought among American business men on both domestic and international questions is disclosed in a list to twenty-six resolutions proposed by organizations which are members of the Chamber of Commerce of the United States for consideration during the annual meeting of the National Chamber in New York, May 8-11.

The resolutions were submitted by local chambers of commerce, and by industrial associations or other trade organizations. They are widely varied in subject, including aviation, canals, coal, Congressional procedure, European affairs, Federal employee questions, Federal taxation, immigration, merchant marine matters, postal service, regulation of public utilities, reclamation, waterways. Cities from which they were submitted include Detroit, Boston, Tallahassee, Fla., Charleston, W. Va., Chicago, Rochester, and New Orleans. Among the associations and organizations, as distinct from the chambers of commerce, that sent in proposed declarations include National Coal Association, Illinois Manufacturers Association, American Electric Railway Association, American Gas Association, and American Institute of Consulting Engineers.

Western Road Shows Gain

The Chicago, St. Paul, Minneapolis & Omaha Railway Co. recently issued its report of earnings for the year 1922, showing net income of $1,177,929 against a deficit in 1921 of $285,677. Despite labor troubles during 1922 the road was able to reduce its operating expenses $2,095,263, which more than offset a reduction of $336,401 in operating revenue.

Personals

O. D. MILLER has been elected secretary-treasurer of the Consolidated Machine Tool Corp. of America, New York. Mr. Miller was formerly assistant secretary and treasurer.

GUY WILSON, formerly with the Traffic Motor Truck Corp., St. Louis, Mo. which recently merged with other concerns to form the National Motors Corp. has announced plans for a new $3,000,000 company to be known as Victor Motors, Inc. for the manufacture of three types of automobiles — the heavy duty, the speed truck and the taxicab.

E. J. STEINBERG has resigned as resident engineer in Milwaukee for the Railroad Commission of Wisconsin, effective June 1, to accept the position of general manager of the properties of the Wisconsin Valley Power Co. at Wausau, Wis. He was associated with the Commission for 10 years.

H. P. HUBBELL, formerly sales manager of the Midvale Co., in St. Louis, Mo. and J. B. SHARP, his former assistant, will open an iron and steel products brokerage office under the firm name of Hubbell & Sharp. The two men have been with the Midvale Co. or its predecessors for 25 years.

L. R. NOURIE, formerly with the Pittsburgh office of Manning, Maxwell & Moore, is now connected with the Thomas Spacing Machine Co., Pittsburgh, and will have charge of sales in that district.

C. T. PRICE, formerly field secretary for the National Metal Trades Association, Chicago, has been appointed secretary and treasurer of the Gas Products Association which is an organization composed of the manufacturers of oxygen and hydrogen.

R. R. SAFFORD, formerly Minneapolis manager of S. F. Bowser & Co., Fort Wayne, Ind., has been appointed manager of S. F. Bowser & Co. of Texas, with offices in Dallas, to succeed L. P. Murray, who has resigned to enter a new line of work. Mr. Murray was for several years vice-president of the Dallas branch of the company.

R. G. CONKLIN, formerly a salesman for S. F. Bowser & Co., Fort Wayne, Ind., with headquarters in Minneapolis, has been appointed manager of the Minneapolis district succeeding R. R. Safford.

B. H. RHYNEARSON has been appointed manager of the "good as new" department of the Vonnegut Machinery Co., Indianapolis, Ind. Mr. Rhynearson has been with this firm for some time and was formerly connected with the Millholland Machine Co. and the E. A. Kinsey Co.

ALBERT PHILLIPS, formerly in the speciality department of the American Radiator Co., Buffalo, has been appointed manager of the brass goods department of Manning, Maxwell & Moore, Buffalo district. He succeeds RAYMOND F. WOLF, who has gone with the Nelson Valve Co., Philadelphia.

E. L. DOTY, who has been the district service manager of the Buffalo branch of the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., has been appointed engineering assistant in the service department with headquarters at East Pittsburgh. He is succeeded in Buffalo by J. A. Atkinson.

GEORGE T. AITKEN, formerly Buffalo manager for the Syracuse Supply Co., has become a member of the firm of D. R. Clarkson & Co., Inc., of Rochester. Mr. Aitken will have charge of the Buffalo office for the company.

ROBERT H. SCHAFER, works manager of the Textile-Finishing Machinery Co., Providence, R. I., was given a farewell dinner at the Hotel Dreyfus recently by the executive staff of the company. Mr. Schafer has resigned to accept a position with the Thurston Manufacturing Co., Providence, R. I., as general manager.

C. C. JOYS, JR., eastern district and export manager of the Steel & Tube Co. of America, with headquarters in New York, has been elected a director and vice-president of the Lucy Manufacturing Corp., in charge of all sales branches in the United States.

G. F. GOODSON of the American Equipment Co., Detroit, Mich., will sail for England on May 12 to be gone for six weeks.

GRAEME ROSS has been appointed manager of the Kansas City, Mo., office of the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Mr. Ross succeeds F. F. ROSSMAN, who resigned to accept the vice-presidency of the Mobile Light & Railway Co., Mobile, Ala.

JOHN L. HARRINGTON, president of the American Society of Mechanical Engineers, a member of the firm of Harrington Howard and Ash, bridge builders of Kansas City, Mo., addressed the Denver and Colorado council of the American Society of Mechanical Engineers and the Colorado chapter of the American Institute of Electrical Engineers, in Denver, April 25, on: "The Function and Position of the Engineer in Our Civilization."

F. MORTON CLARK has been made district sales manager for the New York district of the Bridgeport Brass Co., Bridgeport, Conn.

ARTHUR J. NELSON has been made sales manager of the fabricated division of the Bridgeport Brass Co., Bridgeport, Conn.

G. L. MARKLAND, JR., of the Philadelphia Gear Works, WILLIAM P. ROSS, of William Cramp & Son Ship & Engine Building Co., and H. T. MADISON, of the Westinghouse Electric & Manufacturing Co., have been named on a Philadelphia Chamber of Commerce committeee to study methods of increasing man-power in industry.

HERMAN L. WINTERER is at the head of a recently organized company dealing in second-hand traveling cranes in Philadelphia.

SAMUEL M. VAUCLAIN, president of the Baldwin Locomotive Works, has returned from a trip through the south and southwest, traveling more than 4,000 miles. He made 200 speeches, advocating public confidence in the railroads.

FRANK B. REED, president of the Clearfield Machine Co., was presented with a silver loving cup by employees of the company upon his return from a vacation trip to Florida, a testimonial dinner being given the company head at the Hotel Jordon, Clearfield, Pa. The testimonial was held on his seventieth birthday anniversary. S. Boyd Smith, plant manager, made the presentation speech.

Business Items

Cyril J. Bath & Co., machinery dealers of Cleveland, Ohio, have moved their offices from 1603 to 1738 St. Clair St., offices and warerooms being under one roof.

The Ebco Machine Corp., New York City, announces the removal of its offices and factory to its new building, 345-349 West 40th St.

The American Gear Grinder Co., Detroit, Mich., has changed its name to the American Grinder Co.

The plant and equipment of the Hurlbut-Rogers Broach Co., Hudson, Mass., has been purchased by the Paramount Specialty Tool Co., Waltham, Mass., and the purchaser has moved its equipment from Waltham to Hudson where increased facilities for the manufacture of broaches will be installed. The combined plants will be known as the Paramount Specialty Tool Co., Hudson, Mass.

Richey, Browne & Donald, Inc., is the name of a new Madison, Wis., corporation having $300,000 capital stock, to manufacture metal products of all descriptions. The incorporators are A. C. Richey, R. A. and R. J. Browne.

The J. I. Case Plow Works, Racine, Wis., has given a term lease of its large foundry to the Standard Foundry Co. of Racine, which requires at least for a time a capacity considerably in excess of its own for the production of automobile engine cylinder castings. A crew of 100 molders has been installed in the Case foundry, which has been mainly inoperative during the past two years because of the limited market for plows and other farm implements and machinery.

A new terminal plant, including roundhouse, car and locomotive repair and service shop, power plant, two turntables and an ice plant, all costing $350,000 to $400,000, is planned by the Chicago & Northwestern Railroad at Madison, Wis., an important division point. The main building will be 150x250 ft., of brick and steel.

Fred M. Young and associates from Milwaukee, represented by E. M. Alexander, attorney, who recently bid in all of the assets of the bankrupt Perfex Radiator Co., Racine, Wis., have organized the Racine Radiator Co., which is continuing the business. The plant was kept in operation during the receivership, with Mr. Young as general manager in behalf of the receiver. The sale price was $125,000 for property valued at $344,000 in bankruptcy appraisals. The new corporation has a capital of 2,000 shares of non-par common stock and $35,000 preferred stock. The principal business is to manufacture automobile radiators.

The Prime Mfg. Co., 653 Clinton St., Milwaukee, Wis., manufacturing brass and bronze castings and parts for the railroad, automobile and other industries, has increased its capital stock from $400,000 to $500,000 for further extensions of plant and equipment and working capital. Orton L. Prime is president, and D. T. Allen, secretary-treasurer.

The Sloss-Sheffield Steel and Iron Co., Birmingham, Ala., the largest producer of merchant iron in the South, has bought the entire properties of the Sheffield Iron Corp., paying $265,000, and the assumption of a bonded debt of $585,000, evidenced by 6 per cent 15-year bonds issued in 1917.

The property consists of three Cole blast furnaces at Sheffield, Ala. and mineral lands in Walker, Colbert, Franklin and Cherokee counties in Alabama, and in Lawrence county, Tenn.

The offices of the Bendix Engineering Works have been moved to Room 1959, Illinois Merchants Bank Building, Jackson Boulevard and Clark St., Chicago.

The Pure Carbon Co., Wellsville, N. Y., will be represented in the Minneapolis, Minn., district by the Charles A. Etem Co. of that city.

The Consolidated Tool Works, New York City, has announced that a new price list has been issued.

The Bridgeport Brass Co., Bridgeport, Conn., announces the removal of its New York office from the Woolworth Building to the Pershing Square Building which is situated between 41st and 42nd Sts. on Park Avenue.

Export Opportunities

The Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C., has inquiries for the agencies of machinery and machine tools. Any information desired regarding these opportunities can be secured from the above address by referring to the number following each item.

Machines for the manufacture of belts, such as leather cutting and polishing machines, leather sawing machines for buckles, and leather lining and ornamenting machines. Prague Czecho Slovakia. Purchase. Reference No. 6208.

Machinery for making buckles of all kinds, especially for clothing. Brazil. Purchase. Reference No. 6209.

Machines for the manufacture of asbestos slates and plates, ceramic and glass tiles, concrete paving tiles and concrete paving tiles with incrustations. Antwerp, Belgium. Purchase. Reference No. 6210.

Welded iron pipes of 5m. length, shipments of twenty tons. Basel, Switzerland. Purchase. Reference No. 6213.

Machine tools such as are used by manufacturers and builders of marine steam engines and boilers. Vigo, Spain. Purchase and agency. Reference No. 6211.

Lathes. Aarhus, Denmark. Agency. Reference No. 6223.

Forthcoming Meetings

National Association of Manufacturers. Annual convention. Waldorf-Astoria Hotel, New York City. May 14-15-16. General offices, 50 Church St., New York City.

National Association of Purchasing Agents. Annual convention, Cleveland, May 15 to 18. H. R. Heydon, 19 Park Place, New York City, secretary.

National Supply and Machinery Dealers' Association; Southern Supply and Machinery Dealers' Association; and the American Supply and Machinery Manufacturers' Association, triple convention, in Cincinnati, Ohio, May 17, 18, 19, 1923. F. D. Mitchell, 1819 Broadway, New York City, is secretary.

American Society of Mechanical Engineers. Spring meeting at Montreal, Can., May 28 to 31. Calvin W. Rice, 29 W. 39th St., New York City.

American Society for Testing Materials. Annual meeting at Atlantic City, June, 1923. C. L. Warwick, 1315 Spruce St., Philadelphia, is secretary.

Society of Automotive Engineers. Summer Meeting. Spring Lake, N. J., June 19 to 23.

American Society for Steel Treating. Eastern sectional meeting, Bethlehem, Pa., George C. Lilly, Superintendent of Heat Treatment, Bethlehem Steel Co., Bethlehem, Pa. June 14 and 15. Hotel reservations through Bethlehem Steel Co.,

American Society for Testing Materials. Twenty-sixth annual meeting. Calfonte-Haddon Hall, Atlantic City, N. J., June 25 to 29. Headquarters, Engineers Club Building, 1315 Spruce St., Philadelphia, Pa.

The Weekly Price Guide

RISE AND FALL OF THE MARKET

Advances—Blue annealed steel sheets up 10c.; galvanized, 25c. per 100 lb. at Pittsburgh mill. Sheets, pipe and tin plate in heavy demand at present; slight let up in demand for shapes, plates and bars. Steel sheets, hoops, plates, shapes, bars, bands and cold finished products higher in New York warehouses.

Tin quoted at 46⅝c. in New York, against 44c. per lb. one week ago; market rising steadily.

Declines—Undertone of pig-iron market weaker; prices, however, holding at nominal levels. Steel bars, shapes and plates more quiet. Dropping off in demand for oil storage tank plates and car material. Plates quoted at $2.50@$2.65 per 100 lb., f.o.b. mill, for deferred deliveries; earlier shipments commanding $2.75. Shapes, $2.50@$2.60, shipped at convenience of mill; $2.70 named where deliveries are specified. Bars, quoted as low as $2.40 for indefinite delivery; $2.65 and higher on orders involving earlier shipping specifications.

IRON AND STEEL

PIG IRON — Per gross ton — Quotations compiled by The Matthew Addy Co.:

CINCINNATI	
No. 2 Southern	$31.55
Northern Basic	32.27
Southern Ohio No. 2	33.27
NEW YORK—Tidewater Delivery	
Southern No. 2 (silicon 2.25@2.75)	34.94
BIRMINGHAM	
No. 2 Foundry	27.00
PHILADELPHIA	
Eastern Pa., No. 2x (silicon 2.25@2.75)	32.64
Virginia No. 2	35.17
Basic	31.50
Grey Forge	31 00
CHICAGO	
No. 2 Foundry local	33.00
No. 2 Foundry, Southern (silicon 2.25@2.75)	33.01
PITTSBURGH, including freight charge from Valley	
No. 2 Foundry	31 00
Basic	31 00
Bessemer	31 00

IRON MACHINERY CASTINGS—Cost in cents per lb. of 100 flywheels, 6-in. face x 24-in. dia., hub not cored, good quality gray iron, weight 275 lb.:

Detroit	5.00
Cleveland	5.60@6.25
Cincinnati	4.00@6.00
New York	5.50@5.75
Chicago	4.00@5.00

SHEETS—Quotations are in cents per pound in various cities from warehouse; also the base quotations from mill:

Blue Annealed	Pittsburgh, Large Mill Lots	New York	Cleveland	Chicago
No. 10	2.65@3.35	4.59	3.90	4.15
No. 12	2.75@3.45	4.64	3.95	4.20
No. 14	2.85@3.55	4.69	4.00	4.25
No. 16	3.05@3.75	4.79	4.10	4.35
Black				
Nos. 17 and 21.	3.35@3.85	4.95	4.55	4.85
Nos. 22 and 24.	3.40@3.90	5.00	4.60	4.85
Nos. 25 and 26.	3.45@3.95	5.05	4.65	4.90
No. 28	3.50@4.00	5.15	4.75	5.00

Galvanized	Pittsburgh	New York	Cleveland	Chicago
Nos. 10 and 11.	4.00@4.75	5.15	4.80	5.10
Nos. 12 and 14.	4.10@4.85	5.25	4.90	5.20
Nos. 17 and 21.	4.40@5.15	5.55	5.20	....
Nos. 22 and 24.	4.55@5.30	5.70	5.35	5.65
No. 26	4.70@5.45	5.85	5.60	5 80
No. 28	5.00@5 75	6.15	5.90	6.10

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

Steel BUTT WELD Inches	Black	Galv.	Iron Inches	Black	Galv.
1 to 3	62	50½	¾ to 1¼	30	13
LAP WELD					
2	55	43½	2	23	7
2½ to 6	59	47½	2½ to 4	26	11
7 to 8	56	43½	4½ to 6	28	13
9 to 12	54	41½	7 to 12	26	11
BUTT WELD, EXTRA STRONG, PLAIN ENDS					
1 to 1¼	60	49½	¾ to 1¼	30	14
2 to 3	61	50½			
LAP WELD, EXTRA STRONG, PLAIN ENDS					
2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 to 8	52	39½	7 to 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

WROUGHT PIPE—Warehouse discounts as follows:

	New York Black	New York Galv.	Cleveland Black	Cleveland Galv.	Chicago Black	Chicago Galv.
1 to 3 in. steel butt welded	52%	39%	55½%	43½%	62½%	48½%
2½ to 6 in. steel lap welded	49%	36%	53½%	40½%	59½%	45½%

Malleable fittings: Classes B and C, banded, from New York stock sell at list plus 10%. Cast iron, standard sizes, 21½% off.

MISCELLANEOUS—Warehouse prices in cents per pound in 100-lb. lots:

	New York	Cleveland	Chicago
Open hearth spring steel (base)	5.00	6 00	4.50
Spring steel (light) (base)	7.00	6 00	6.00
Coppered Bessemer rods (base)	7.50@8.00	8 00	6.10
Hoop steel	5.19	4.66	4.55
Cold rolled strip steel	7.50	8.25	7.25
Floor plates	5.80	5.66	5.80
Cold finished shafting or screw	4.40	3.90	4.30
Cold finished flats, squares	4.90	4.40	4.80
Structural shapes (base)	3.64	3.46	3.40
Soft steel bars (base)	3.54	3.36	3.32½
Soft steel bar shapes (base)	3.54	3.36	3.32½
Soft steel bands (base)	4.39	3.61	3.95
Tank plates (base)	3.64	3 71	3.40
Bar iron (3.25 at mill)	3.54	3.36	3.32½
Carbon tool steel	11.00	....	....
Drill rod (from list)	55%	40@55%	50%
Electric welding wire:			
3/32	8.50		14.00
⅛	7.35		12.25
5/32 to ¼	7.10		11.00

METALS

Current Prices in Cents Per Pound

Copper, electrolytic (up to carlots), New York			17.12½
Tin, 5-ton lots, New York			46.62½
Lead (up to carlots), St. Louis	7.55;	New York.	8.12½
Zinc (up to carlots), St. Louis	7.00;	New York.	7.40

	New York	Cleveland	Chicago
Aluminum, 98 to 99% ingots, 1-15 ton lots	26.20	28.00	28.50
Antimony (Chinese), ton spot	8.87½	11.50	9.50
Copper sheets, base	26.50	25.75	23.00
Copper wire (l.c.l.)	19.62½	22.00	16.25
Copper bars (l.c.l.)	23.50	25.25	19.50
Copper tubing (l.c.l.)	28.00	30.25	23.00
Brass sheets (l.c.l.)	21.75	25.25	18.75
Brass tubing (l.c.l.)	26.50	30.75	20.50

Shop Materials and Supplies

METALS—Continued

	New York	Cleveland	Chicago
Brass rods (l. c. l.)	20.00	21.00	15.75
Brass wire (l. c. l.)	22.25	22.00	.....
Zinc sheets (casks)	11.00	10.90	.....
Solder (½ and ½), (caselots)	33.50	29.50@31.50	20.00
Babbitt metal (83% tin)	65.00	56.00	41.00
Babbitt metal (35% tin)	40.00	18.50	18.00
Nickel (ingot and shot), Bayonne, N. J.	29.00	.....	35 00
Nickel (electrolytic), Bayonne, N. J.	32.00	.....	35.00

SPECIAL NICKEL AND ALLOYS—Price in cents per lb.

Malleable nickel sheet (base)	55
Hot rolled rods, Grade "A" (base)	50
Cold drawn rods, Grade "A" (base)	60
Copper nickel ingots	37
Hot rolled copper nickel rods (base)	45
Manganese nickel hot rolled rods "E"—low manganese (base)	54
Manganese nickel hot rolled rods "D"—high manganese (base)	57

Base price of monel metal in cents per lb., f.o.b. Huntington, W. Va.:

Shot	32.00	Hot rolled machined rods (base)	48.00
Blocks	32.00	Hot rolled rods (base)	40.00
Ingots	38.00	Cold drawn rods (base)	46.00
Hot rolled sheets (base)			45.00

OLD METALS—Dealers' purchasing prices in cents per pound:

	New York	Cleveland	Chicago
Copper, heavy, and crucible	14.50@15.00	14.00	15.00
Copper, heavy, and wire	14.25@14.75	13.50	14 00
Copper, light, and bottoms	12.25@12.75	12.00	12.75
Lead, heavy	6.00@ 6.50	6.50	6.75
Lead, tea	5.50@ 5.75	5.00	5.75
Brass, heavy, yellow	8.50@ 8.75	....	9.00
Brass, heavy, red	12.00@12.50	12.00	12.00
Brass, light	7.00@ 7.50	7 50	8.00
No. 1 yellow brass turnings	8.50@ 8.75	8.50	8.50
Zinc	4 75@ 5.25	4.50	4.25

TIN PLATES—American Charcoal Plates—Bright—Cents per lb.

		New York	Cleveland	Chicago
"AAA" Grade:				
IC,	20x28, 112 sheets	22.00	19.50	18.50
IX,	20x28, 112 sheets	24.50	22.25	20.90
"A" Grade:				
IC,	20x28, 112 sheets	19.50	17.00	17.00
IX,	20x28, 112 sheets	22.00	19.75	19.60
Coke Plates, Bright				
Prime, 20x28 in.:				
100-lb.,	112 sheets	13.00	12.20	14.50
IC,	112 sheets	13.30	12.60	14.80
Terne Plate				
Small lots, 8-lb. Coating:				
100-lb.,	14x20	7.00	6.65	7.25
IC,	14x20	7.25	6.55	7.40

MISCELLANEOUS

	New York	Cleveland	Chicago
Cotton waste, white, per lb.	$0.10@0.13	$0.15	$0.11¼
Cotton waste, colored, per lb.	.07@.12	.12	.08
Wiping cloths, 13½x13½, per lb.	.11@.11½	36.00 per M	.10
Wiping cloths, 13¼x20 ½, per lb.	....	52.00 per M	.13
Sal soda, per 100 lb.	1.65	3.50	2.65
Roll sulphur, per 100 lb.	2.60	3.25	3.50
Linseed oil, per gal., 5 bbl. lots	1.16	1.30	1.37
White lead, dry or in oil	100 lb. kegs.	New York, 14.50	
Red lead, dry	100 lb. kegs.	New York, 14.50	
Red lead, in oil	100 lb. kegs.	New York, 16.00	
Fire clay, per 100 lb. bag		.65	.60
Coke, prompt furnace, Connellsville	per net ton	$5.50@6.00	
Coke, prompt foundry, Connellsville	per net ton	7.00@7.50	

SHOP SUPPLIES

Current Discounts from Standard Lists

	New York	Cleveland	Chicago
Machine Bolts:			
All sizes up to 1x30 in.	30%	50-10%	45-5%
1½ and 1¼x3 in. up to 12 in.	15%	50%	50%
With cold punched hex. nuts up to 1 in. diam. (plus std. extra of 10%)	15%	$3.50 net	.....
With hot pressed hex. nuts up to 1x30 in. (plus std. extra of 10%)	20%	3.50 net	$4.00 off
Button head bolts, with hex. nuts	List net	List net	.....
Hex. head and hex. nut bolts	List net	.....	65-5%
Lag screws, coach screws	30%	.....	60-5%
Square and hex. head cap screws	60%	70%	70-10%
Carriage bolts, up to 1 in. x 30 in.	25%	45%	40-5%
Bolt ends, with hot pressed nuts	30%	.....	55%
Tap bolts, hex. head, list plus	35%	.....	.....
Semi-finished nuts, ⅜ and smaller	60%	.....	.....
Semi-finished nuts, ½ and larger	55%	65-10%	80%
Case-hardened nuts	40%	.....	.....
Washers, cast iron, ½ in., per 100 lb. (net)	$6.50	$4.00	$3.50
Washers, cast iron, ⅝ in., per 100 lb. (net)	5.50	4.00	3.50
Washers, round plate, per 100 lb. Off list	1.50	4.00	3.50 net
Nuts, hot pressed, sq., per 100 lb. Off list	List net	2.75	2.50
Nuts, hot pressed, hex., per 100 lb. Off list	List net	2.75	2.50
Nuts, cold punched, sq., per 100 lb. Off list	List net	2.75	2.50
Nuts, cold punched, hex., per 100 lb. Off list	List net	2.75	2.50
Rivets:			
Rivets, 7/16 in. dia. and smaller	40%	50-10%	50%
Rivets, tinned	40%	50-10%	4½c. net
Button heads ¾-in., ⅞-in., 1x2 in. to 5 in., per 100 lb. (net)	$5.50	$3.90	$3.75
Cone heads, ditto (net)	5.60	4.00	3.85
1½ to 1¾-in. long, all diameters, *EXTRA* per 100 lb.	0.25	.....	0.15
¾ in. diameter *EXTRA*	0.15	.....	0.15
½ in. diameter *EXTRA*	0.50	.....	0.50
1 in. long, and shorter *EXTRA*	0.50	.....	0.50
Longer than 5 in. *EXTRA*	0.25	.....	0.25
Less than 200 lb. *EXTRA*	0.50	.....	0.50
Countersunk heads *EXTRA*	0.35	.....	$3.70 base

Lard cutting oil (50 gal. bbl.) per gal.	$0.60	$0.50	$0.67½
Machine lubricant, medium-bodied (50 gal. bbl.), per gal.	0.297	0.35	0.40
Belting—Present discounts from list in fair quantities (½ doz. rolls).			
Leather—List price, New York, per ply, 12-in. wide, per lin. ft., $2.88:			
Medium grade	30-10%	40½%	50%
Heavy grade	20-5-2½%	30-5%	40-5%
Rubber and duck:			
First grade	50-10-5%	50-10%	40-10%
Second grade	60-10%	60-5%	60-5%
Abrasive materials—In sheets 9x11 in.,			
No. 1 grade, per ream of 480 sheets:			
Flint paper	$5.84	$5.84	$6.48
Emery paper	8.80	11.00	8.80
Emery cloth	27.84	31.12	29.48
Flint cloth, regular weight, width 3½ in., No. 1 grade, per 50 yd. roll	4.50	4.28	4.95
Emery discs, 6 in. dia., No. 1 grade, per 100:			
Paper	1.32	1.24	1.40
Cloth	3.02	2.67	3.20

New and Enlarged Shops

Machine Tools Wanted

Kan., Bonner Springs—Kansas Portland Cement Co.—one bell drive alligator shears to take at least 1 in. rod.

Kan., Newton—D. W. Broyles, Main St. (garage)—power drill press, lathe and emery stand.

Kan., Newton—Monroe & Kirby (garage) —power lathe.

Kan., Newton — Bochaus Machine and Welding Co., 116 East 3rd St., A. H. Bochaus, Purch. Agt.—power cylinder grinder.

Kan., Newton—Wright Electric & Battery Co., 212 Main St., B. Wright, Purch. Agt.—power drill press and power lathe, (used preferred).

Mass., Chelsea (Boston P. O.)—Mexican Petroleum Corp., Eastern Ave.—machinery for proposed repair and machine shop.

Mass., Gardner—Central Oil & Gas Stove Co. — machinery for proposed $40,000 factory and machine shop.

Mass., West Somerville (Boston P. O.)—F. B. Horsman—lathes, planer, upright drill, press, punch, shafting, pulleys, motor and small tools for new machine shop.

Mich., Detroit — City, Dept. Purchases and Supplies, 700 Marquette Bldg., G. J. Finn, Comr.—one 42 in. drill press.

Mich., Detroit — Dept. Street Railways, Shoemaker and St. Jean Aves., G. J. Finn, Comr. Purchases and Supplies, 700 Marquette Bldg.—two portable electric track drills.

Mich., Detroit—Superior Piston Ring Co., 226 Bates St.—grinding machine for finishing piston rings.

Mo., Kansas City—Bauer Machine Co., 2328 Harrison St.—14 or 16 in. lathe.

N. Y., Adams Center—G. J. Davis Co., Main St. (machine shop and sheet metal)—20 in. vertical post drill and high speed twist drills.

N. Y., Brooklyn — W. H. Nicholls Co., Inc., 2 College Pl., (moulding machinery)—42 in. Bullard New Era vertical turret boring mill (used).

N. Y., Buffalo—Buffalo General Electric Co., Electric Bldg.—equipment for repairing trucks and automobiles.

N. Y., Buffalo—W. H. McMullen, Fargo Ave. and Niagara St. — machinery and equipment for auto repair shop, incl. air compressor, press, drill, etc.

N. Y., Buffalo—Truck Equipment Corp., Fillmore Ave. and Appenheimer St., E. R. Boeck, pres.—machinery and equipment for manufacture and installation of auto truck equipment.

N. Y., Carthage—W. G. Hamilton Co., 259 State St. (manufacturer of metal novelties)—small power punch press to operate on light gage sheet metal.

N. Y., Dexter—Dexter Sulphite Pulp & Paper Co., C. Campbell, Purch. Agt.—keyseater, two 2 ton chain hoists and hand tools for pattern shop.

N. Y., La Fargeville—E. D. Schell Co. (machine shop and service station)—milling machine and portable electric drill, 220 volt a.c.

N. Y., La Fargeville—E. A. Vandewalker (machine shop and garage)—14 or 16 in. x 8 ft. back geared engine lathe and about 140 ft. of 1⅛ in. cold rolled shafting.

N. Y., Malone—T. Hinds Co., 107 Catherine St. (machine shop and foundry), J. B. Hinds, Purch. Agt.—18 in. x 6 ft. double back geared engine lathe.

N. Y., New York—G. E. Affleck, 93 Nassau St. (machinery)—3 shapers 12 x 20 in. stroke, Walker surface grinder, Pond lathe and Shuster riveter.

N. Y., New York—A. R. Brown-McFarlane & Co., Ltd., 90 West St.—plate shearing machine for cutting circular plates.

N. Y., New York—M. N. Halpern, Inc., 110 West 40th St.—1¼ in. Knight milling and drilling machine with longitudinal feed and index centers complete (new).

N. Y., Niagara Falls—Bouk & Nielson, Inc., 411 1st St.—garage and repair shop equipment, including drill, tools, press, etc.

N. Y., Tupper Lake—V. Schiavi (stone quarry)—power operated drill sharpener, air compressor and power stone saw.

N. Y., Watertown—G. H. Baltz, 215 Coffeen St. (garage and machine repair)—keyseater.

N. Y., Watertown—McLaughlin & Hawkins Co., Public Sq. (plumbing and steam fitting)—pipe cutting and threading machine up to 6 in.

N. Y., Watertown—Willard Service Sta., 624 State St. (electrical repairing)—high speed vertical sensitive drill and power operated metal saw, 2 x 2 in. or smaller (new or used).

O., Columbus—S. A. Esswein Heating and Plumbing Co., 96 West Broad St., H. Heywood, Mgr.—metal working machinery.

O., East Liverpool — National Products Co.—10 ft. 6 in. bending roll punch, shear, Bull riveting machine, radial drill, 4 ft. swing.

O., Youngstown—M. A. Dignan, Market St.—machinery, tools and equipment for gasoline and service station.

Pa., Allentown—The Independent Oil Co., Inc., Rialto Bldg.—machinery, tools and equipment incl. air compressors, tanks, pumps, etc., for 6 proposed gasoline and service stations.

Pa., Allentown—Lehigh Valley Oil Co., 8th and Walnut Sts.—machinery, tools and equipment incl. air compressors for gasoline and service station.

Pa., Lebanon—Lebanon Eng. & Supply Co., 12th St. along tracks Pennsylvania R.R.—8 ft. power squaring shear to cut No. 18 steel.

Pa., Mansfield — S. B. Bishop, South Main St.—lathe and drill suitable for motor repair.

Pa., Phila.—The Commercial Truck Co. of America, 27th and Brown Sts.—1 Bullard 36 in. New Era vertical turret lathe (used).

Pa., Phila.—The Ford & Kendig Co., 1428 Callowhill St., (pipe coils, etc.)—12 in. pipe cutting and threading machine (used).

Pa., Royersford—G. Bauer, 2nd Ave.—machine shop equipment complete.

Tex., San Antonio—Southwestern Seating Co., 816 South Presa St.—electric drill press, drills, electric wrenches and screw drivers.

Va., Gordonsville — Gordonsville Motor Co., Inc. (automobile repair shop)—lathe, drill press and battery charging plant.

Va., Gordonsville—W. N. Jefferson (automobile repair shop)—riveting machine, drill press, power emery wheel, air compressor and small lathe.

Va., Richmond—Cardwell Machine Co., 1900 East Cary St., G. J. Freedley, pres. —electrically operated hammer for blacksmith shop.

Va., Richmond—T. N. Kendler, 5 East Marshall St. (cornice maker)—one 30 in. square shears, one portable pipe vise, stocks and dies.

Wis., Big Bend—O. Eisner, (auto repairs) —20 in. drill press and emery grinder.

Wis., Burlington—Batefield Bros. Co.—auto repair machinery incl. several ton drill press, lathe, small machinery and tools for proposed garage.

Wis., Fenwood—Automotive Service Co. —18 in. x 10 ft. lathe, gas welder, air compressor, chain hoist, set of reamers and drills.

Wis., Mayville—Feilbach Mfg. Co., A. O. Feilbach, Purch. Agt.—machinery and tools to manufacture valve lifting tools.

Wis., Milwaukee—P. Goelzer, 1210 3rd St.—30 in. squaring shears.

Wis., Sheboygan—F. Hensel Co., Center and North 7th Sts.—drill press, small tools and automatic filling gasoline pump for proposed garage.

Que., Montreal—O. Caron, 464 Lasalle St.—complete equipment for garage and auto repairs.

Que., Montreal—Henderson Barurck Co., Ltd., 5 Olier St. (tinsmiths, etc.), O. Barurck, Purch. Agt.—additional sheet metal working machinery.

Que., Montreal—A. Patenaude, 895 Henri Julian St.—equipment for garage on Savoie St., incl. 1 lathe, etc.

Machinery Wanted

Ala., Alexander City—Avondale Mills Co.—40,000 cotton spindles for proposed $1,000,000 plant.

Ala., Garden City—Kimbrell Heading Co. —heading jointer and hay baling press.

Del., Millville — E. Dukes — basket and barrel making machinery and equipment, including conveying and transmission equipment, also nailing machines.

Fla., Clearwater—Clearwater Cooperage Co., C. E. Murray, Pres.—cooperage plant machinery and equipment incl. conveying and transmission machinery.

Fla., Kissimmee—Wood Tex. Co.—machinery to manufacture fibre sawdust, capacity 1½ cords of wood per hour.

Fla., Ocala—R. L. Martin, 9 Merchants Block—machines for the manufacture of sand asphalt blocks.

Ga., Barnesville—Barnesville Planing Mill—300 ft. lumber conveyor.

Ga., Wiley—J. B. McCracklin—complete sawmill outfit.

Ind., Huntington—Majestic Fdry & Furnace Co., Market St.—foundry equipment, also furnace manufacturing machinery and equipment.

Ind., Kokomo—J. E. Hershberger, P. O. Box 602 (job printer)—15 in. and 24½ in. paper cutters, job press not smaller than 6½ x 9.

Ia., Dubuque—O. E. Carr, c/o City Hall —2 large air compressors.

Kan., Newton—Rodhagen & Wormeck, 129 East 3rd St. (machine shop and woodworking plant)—power belt sander and Universal saw.

Kan., Wichita—O. Kinzel, 144 North Market St.—electric power blue print machine with motor attachment.

Kan., Wichita—Wichita Steam Laundry, 117-19 West 1st St.—laundry equipment for proposed plant.

Ky., Ashland—Gunnel Shoe Co.—complete machinery and equipment for $50,000 shoe manufacturing plant.

Ky., Louisville—Beha Laundry Co., 813 Clay St.—equipment, including tubs, mangles, conveyors, etc., for proposed $25,000 laundry.

Md., Baltimore—L. E. Jones Wire & Iron Wks., 321 North Calvert St.—one wire straightener, F. P. Schuster & Co. make preferred, (used).

Mich., Detroit—Fire Commissioners, c/o Dept. Purchases and Supplies, 700 Marquette Bldg., C. J. Finn, Comr.—receiving bids until May 14, one portable air compressor and pneumatic tools.

Minn., Minneapolis—Howland & Waltz Co., Ltd., 355 Lumber Exchange—machinery for pulp and paper plant to be erected at Kalso, B. C.

Mo., Kansas City—Amer. Sash & Door Co., 16th and Bellfontaine Sts., (mill work, show cases, bank fixtures)—wood working machinery, general machines for scroll wood work, and wood lathes (new).

Mo., Kansas City—Bd. Educ., 9th and Locust Sts., A. Jackson, Purch. Agt.—woodworking, iron working and electrical machinery for manual training department of schools.

Mo., St. Louis—G. Clark, 2913 Montgomery St. (automobile repairs)—flexible shaft, buffer, skiver and air pump.

Neb., North Platte—Walthers Print Shop —8 x 12 C and P job printing press and other equipment.

N. Y., Adams—W. S. Rice Mfg. Co. (truss factory)—power operated carborundum stone for grinding, also small bandsaw with frame and table.

N. Y., Buffalo—City, H. L. Beck, City Archt.—laundry equipment for proposed laundry at J. N. Adam Memorial Hospital, Perrysburg.

N. Y., Carthage—D. J. Renaud & Son, 672 West End Ave. (foundry)—air operated chipper, air compressor, tank, tubing and 200 lb. press.

N. Y., Elmira — Elmira Fdry. Co., J. McCann, Mgr.—foundry equipment, incl. pattern working machinery, both metal and wood.

N. Y., Gouverneur—W. H. Loomis Talc Corp. (talc mining)—hoisting machinery and equipment.

N. Y., Jamestown—Skinners Place, R. F. D. Lake Rd.—air compressor outfit for gasoline and service station.

N. Y., Lakewood—G. W. Hamm—forge, blower, tongs and other blacksmithing machinery and equipment.

N. Y., New York—Conley Foil Co., 521 West 25th St.—one 213 or equal Bliss gauge slitting machine with maximum width cut of 24 in. for 16 gage sheets.

N. Y., Niagara Falls—J. F. Jamrowicz, 1914 Pine Ave.—gasoline service station equipment, including pump, tank, air compressor, tire repair equipment, etc.

N. Y., North Tonawanda—R. T. Jones Lumber Co.—lumber mill machinery and equipment for development of large tract of timber land near here.

N. Y., Peekskill—N. Dains Sons, 100 Water St.—lumber and planing mill machinery and equipment, to replace that which was destroyed by fire.

N. Y., Phila.—Klock Bros. Co., Main St. (machine shop and garage)—two 2½ ton triple geared chain hoists, one with traveler and 210 ft. trackage.

N. Y., Port Henry—Bd. Educ., G. C. Foote, member—metal and woodworking machine tools for vocational training.

N. Y., Rochester—J. E. Embrey, 49 Halstead St.—automatic lathes and hand turning lathes.

N. Y., Rushville—Winter & Powell Canning Co.—corn and pea running machinery, etc., for canning plant.

N. Y., Syracuse—Syracuse—Lighting Co., 339 South Warren St., J. C. De Long, Purch. Agt.—gas manufacturing machinery and equipment for new $3,000,000 plant.

N. Y., Tupper Lake—C. H. Elliot (lumber and mill work)—mortiser.

N. Y., Watertown—Burns Bros. & Haley Inc., Jefferson County Bank Bldg. (contractors), W. Haley, Purch. Agt.—heavy duty power operated air compressor for air drills.

N. Y., Watertown—F. A. Green, 603 Leray St.—bench buzz planer, 12 in. blade, and pattern makers band saw.

N. C., Kimesville—M. A. Carson—drill press, bandsaw and other woodworking equipment.

N. C., Lexington—C. M. Wall & Son—complete machinery, including planers, etc., for plant for the manufacture of boxes, box shooks, crating material, etc.

N. C., Rutherfordton—Bd. Educ.—complete vocational equipment for $200,000 school, including lathes, drills, presses, saws and woodworking machinery.

O., Columbus—Columbus Varnish Co., 264 Cozzens St., S. W. Hanna, vice. pres.—equipment for proposed 1 story, 100 x 300 ft. addition to plant.

O., Columbus—C. M. Heisser, 123 East Tower St.—equipment for furniture factory, including cutoff saws and molding machine.

O., Newton Falls—Silent Minister Publishing Co., G. Jones, Secy.—printing plant machinery and equipment.

O., Youngstown — Mahoning Valley Creamery Co., 238 West Boardman St., J. E. Dye, Mgr.—machinery and equipment for creamery plant.

Pa., Corry—Jamestown Gas Stove Corp.—machinery and equipment for stove factory at Jamestown, N. Y.

Pa., Emaus—C. W. Wenner—complete bakeshop equipment.

Pa., New Castle—Atlantic Refining Co.—machinery and equipment, including air compressors, tankage, pumps, etc., for two gasoline and service stations.

Pa., Phila.—R. J. Ederer Thread Co., Unity and Elizabeth Sts., C. L. Ederer, Purch. Agt.—rotary dyeing machines, hydro extractors and other equipment to complete plant.

Pa., Phila.—Enear Printing Co., 1215 Filbert St., A. Enear, Purch. Agt.—Gordon press and accessories.

Pa., Phila.—Largeman, Gray Co., 3360 Frankford Ave. (manufacturer of hosiery), H. Largeman, Purch. Agt.—full fashioned knitting machines, loopers, seamers, etc. for new mill.

Pa., Sellersville—Lyons Artificial Silk Co.—silk looms and machinery for new plant.

Pa., Titusville—N. A. Russell, Box 127—oil well pumping outfit and machinery.

Pa., Troy—J. H. McClelland, Secy.—machinery and equipment for manufacturing shirts.

Pa., Washington—Board of Education—vocational equipment complete incl. lathe, press, saws, etc. for $130,000 school, here.

Pa., Wilkes-Barre — Woodlawn Dairy Products Co., North Washington and East North Sts.—dairy machinery and equipment for proposed branches.

R. I., Anthony—Rosella Mills, Inc., 4 x 4 in. box 25 harness looms, 94 in. between swords, for weaving belts, (used).

R. I., East Greenwich—Greenwich Mills—two 30 harness, 48 in. C & K harness, sample looms, motor driven.

R. I., Providence—Colwell Worsted Mills, Hartford Ave.—500 lb. Bailey yarn dryer (used), one 66 in. Teasel gig and one 66 in. napper.

Tex., Plainview—J. M. Adams, (printer)—power job printing press, power paper cutter, belting, hangers and pulleys.

Va., Gordonsville—Rockland Mining Co.—general flour mill equipment, steam power.

Va., South Boston—J. V. Thompson—woodworking machinery, etc., for proposed veneer plant (used).

W. Va., Charleston—Charleston Market Co., 611 Virginia St.—cold storage and refrigeration machinery for new $400,000 market.

W. Va., Elkins—R. K. Hack—three medium size wood turning lathes, shafting and pulleys.

W. Va., Wheeling—F. Delmerz, 312 Wheeling Bank & Trust Bldg.—16 in. rip saw.

Wis., Eau Claire—Lange Canning Co., Mill and West Madison Sts., G. S. Lange, Pres.—pea canning machinery and conveyors for canning factory at Marengo.

Wis., Evansville—C. Lutz—equipment and machinery for upholstering automobiles, also gasoline storage tanks and pumps for proposed service station.

Wis., Green Bay—The Modern Dairy Co., c/o H. Kuestermann, 333 South Adams St.—large power churn, belting, shafting.

Wis., Green Bay—A. B. Turnbull, 315 Cherry St. (printer)—paper cutting machine, about 16 in.

Wis., Kenosha—American Brass Co., 570 Elizabeth St., C. Judd, Mgr.—special machinery for manufacture of copper wire and 5 or 6 electrically operated cranes for proposed copper wire mill.

Wis., Milwaukee—E. Maier, 660 30th St.—one Universal woodworking machine, to plane, saw and mortise, motor driven.

Wis., Milwaukee—Manufacturers' Box Co., 32 Keefe Ave.—conveyors for proposed addition to factory.

Wis., Milwaukee—A. N. Strack, 744 57th St. (carpentry and woodwork)—one belt sander, medium size.

Wis., Milwaukee—Wisconsin Steel Castings Co., c/o W. C. Wehe, 800 1st National Bank Bldg.—standard size casting machines.

Wis., Oshkosh—Bd. Educ., J. Voss, Comr.—table saw, small jointer, mortiser, twenty two manual training benches and small woodworking tools for new Roosevelt school.

Wis., Oshkosh—J. P. Koeller, 407 West Algoma St.—gasoline storage tanks and pumps for proposed filling station.

Wis., Sheboygan—F. Skaff, 928 Wisconsin St.—ice machine and refrigeration equipment, ice making machinery, belting and shafting for store at Fond du Lac.

Wis., Superior—Maynard Mfg. Co., c/o J. B. Maynard, 1616½ 13th St., (sash and screens)—3 in. stickers and 1 screen stretcher.

Wis., Wisconsin Rapids — Consolidated Power Co., J. Schnobel, Purch. Agt.—4 agitators, pumps, belting and shafting for machine shop and pulp storage tanks at Biron (Wisconsin Rapids P. O.).

Wis., Wausau — Kickbush Wholesale Grocery Co., 126 West Washington Ave.—20 ton ice machine, package conveyor and equipment for warehouse.

B. C., South Vancouver—Dominion Creosoting & Lumber Co., Ltd., North Arm, Fraser River—machinery for proposed sawmill.

Ont., Beaverton — National Furnace & Fdry. Co., Ltd., G. M. Huyche, purch. agt.—foundry equipment.

Ont., Brantford — Brantford Shoe Co., Ltd.—complete equipment for shoe manufacturing.

Ont., Dryden—Bay Gold Mines, Ltd., J. L. McComber, Purch. Agt.—drills, pump, pumping equipment, stamp batteries, etc.

Ont., Elk Lake—Matachewan Canadian Gold Mines, King Edward Hotel Bldg., Toronto—crushers, pumps, compressors, tube and bull mill, cyanide apparatus, stamp mills, rolls, etc.

Ont., Grimsby—Grimsby Fdry. Co., Ltd., T. Worsley, purch. age.—foundry equipment.

Ont., Haileybury — Haileybury Lumber Co.—saws, planers and wood working machines.

Ont., Kitchener—Twin City Sash & Door Co., Ltd., A. H. Koephe, purch. agt.—woodworking machinery and various saws.

Ont., Midland—Pratt & Shanacy, (lumber)—double cutting band saw mill.

Ont., Toronto—A. Weller Co., Lombard St.—planing mill equipment.

Que., Berthierville—J. J. V. Bacon, William St.—sash and door manufacturers—additional woodworking machinery.

Que., Batiscan—St. Maurice Lumber Co.—additional machinery.

Que., Grandes Piles—J. Art Doucet—(sash and door manufacturer) soon in market for woodworking equipment.

Que., Joliette—Joliette Steel Co., Ltd., St. Paul St., P. H. Desrosiers, purch. agt.—additional machinery.

Que., Montreal—Marchand Freres, Ltd., 533 Craig St., E., A Marchand, Purch. Agt.—additional printing presses and equipment.

Que., St. Andrew—Western Quebec Paper Mills, Ltd.—additional machinery to manufacture tissue paper, 6 tons daily capacity.

Que., St. Boniface—E. Aucoin—sash and door equipment, also woodworking machinery.

N. M., Alamgordo—Cloudcraft Land & Lumber Co.—band saws, conveying machinery and other lumber mill machinery and equipment.

P.E.I., Charlotteburg — Guardian Publishing Co., Ltd.—entire equipment for job printing and newspaper plant, to replace fire loss.

H. T., Pearl Harbor—Bureau Yards & Docks, Navy Dept., Wash., D. C.—receiving bids June 13, for refrigerating equipment incl. motor driven compressor, condenser, liquid receiver, brine cooler, motor driven brine pump, oil and scale traps, piping, etc. Alternate bids on self-contained hermetically sealed refrigerating machine or on direct expansion system. L. E. Gregory, ch. of Bureau. Specification 4767.

Metal Working Shops

Calif., San Pedro—A. G. Bailey, Archt., Junior Orpheum Bldg., Los Angeles, is receiving bids for the construction of a 2 story, 100 x 122 ft. garage on 9th St., here, for C. K. Cook. Estimated cost $75,000.

Conn., Bridgeport—Jenkins Bros., 510 Main St., manufacturer of valves, awarded the contract for the construction of a 4 story, 72 x 175 ft. addition to its factory on Water St. Estimated cost $250,000. Noted Mar. 22.

Conn., East Hartford — D. Ravellese, Village St., is having plans prepared for the construction of a 1 story, 60 x 120 ft. garage with 50 x 100 ft. ell, at 6 Pleasant St. Estimated cost $65,000. J. E. Marchetti, 721 Main St., Hartford, Archt.

Conn., Hartford—H. Bland, 521 Park St., will receive bids until May 12, for the construction of a 1 story, 50 x 120 ft. garage. Estimated cost $40,000. Berenson & Moses, 30 Allyn St., Hartford, Archts. Noted Apr. 26.

Conn., Hartford—The Brown Thomson Co., Main St., will soon award the contract for the construction of an 80 x 100 ft. garage. Estimated cost $40,000. J. A. Allen, Jr., 100 Farmington Ave., Hartford, Archt. Noted May 3.

Conn., Hartford—T. J. Hurley, 164 Seymour St., awarded the contract for the construction of a 1 story, 60 x 140 ft. garage at 47 Park St. Estimated cost $45,000.

Conn., Meriden—O. G. Ost, 42 Stone St., awarded the contract for the construction of a 2 story, 40 x 80 ft. garage. Estimated cost $50,000.

Conn., Waterbury—J. H. Cassidy, 144 Bank St., awarded the contract for the construction of a 2 story, 50 x 60 ft. garage on Mitchell Ave. Estimated cost $40,000. Noted Apr. 19.

Conn., Waterbury — The Connecticut Brass Fdry., 600 East Main St., will soon award the contract for the construction of a 2 story, 30 x 40 ft. factory at 660 East Main St. Estimated cost $40,000. H. F. Wenzel, 6 Glen Ridge St., Waterbury, Archt. Noted Apr. 19.

Ill., Chicago—The Chicago Motor Bus Co., 1124 Rosemont Ave., awarded the contract for the construction of a garage at 5201-29 Cottage Grove Ave. Estimated cost $75,000.

Ill., Chicago — The Commodore Garage Co., 812 Crexcent Pl., is having plans prepared for the construction of a 2 story, 100 x 176 ft. garage at 4117-25 Bway. Estimated cost $100,000. D. S. Klafter, 64 West Randolph St., Chicago, Archt.

Ill., Chicago—The Western Electric Co., 52nd and Cicero Sts., is having plans prepared for the construction of a 4 story addition to its plant, to contain 100,000 sq.ft. of floor space, in the suburb of Hawthorne. W. R. Kattelle, c/o owner, Archt.

Ia., Des Moines—The Eagle Iron Wks., Court and South East 3rd Sts., awarded the contract for the construction of a 2 story, 80 x 280 ft. machinery building. Estimated cost $49,187. Noted March 22.

Ky., Louisville—The P. Wells Co., 718 4th St., awarded the contract for the construction of a 3 story, 70 x 200 ft. garage on 3rd St. Estimated cost $100,000.

Md., Hagerstown—The Moller Motor Co., Lewistown, Pa., plans to build an automobile body factory, here. Estimated cost $50,000. Engineer or architect not announced,

Md., Hagerstown—The Western Maryland Ry., Morris Bldg., Baltimore, plans to rebuild the section of its repair shop, which was recently destroyed by fire, here. Loss $150,000. H. R. Pratt, Ch. Engr.

Mass., Chelsea (Boston P. O.)—The Mexican Petroleum Corp., Eastern Ave., will build a 1 story, 35 x 150 ft. repair and machine shop. Cost between $10,000 and $12,000.

Mass., Gardner—The Central Oil & Gas Stove Co. will receive bids this month for the construction of a 3 story, 50 x 100 ft. manufacturing building and machine shop. Estimated cost $40,000. G. A. Johnson, Main St., Worcester, Engr. and Archt.

Mass., Lowell—The Saco Lowell Shops, Dutton St., manufacturers of textile machinery, awarded the contract for the construction of a 2 story, 100 x 360 ft. machine shop. Estimated cost $500,000.

Mass., New Bedford—Riley & Galligan, Olympia Bldg., awarded the contract for the construction of a 1 story, 50 x 180 ft. garage on Mill St. Estimated cost $40,000.

Mass., Westfield—The H. B. Smith Boiler Co. awarded the steel contract for the construction of a 1 story foundry to contain 40,000 sq.ft. of floor space. Estimated cost $70,000.

Mich., Springwells—The Paige Detroit Motor Co., Fort St. and McKinstry Ave., Detroit, is having plans prepared for the construction of a 1 story, 280 x 988 automobile assembly building on Warren Ave., here. A. Kahn, 1000 Marquette Bldg., Detroit, Archt.

Minn., Minneapolis—The Northern States Power Co., 15 South 5th St., will build a 4 story, 60 x 77 x 100 ft. shop and office building at 2820 Marshall St., N. E. Estimated cost $125,000. R. F. Peck, Vice Pres. and Genl. Mgr.

Mo., Monett—The St. Louis-San Francisco Ry. Co., Frisco Bldg., St. Louis, is rebuilding its roundhouse, machine shops, etc., which were recently destroyed by fire, here. Estimated cost $500,000. Noted Apr. 19.

N. Y., Jamestown—The Jamestown Metal Desk Co., Blackstone Ave., plans to build a 1 story, 73 x 170 ft. addition to its plant. Estimated cost $55,000. E. Jones, Mgr. Engineer or architect not announced.

N. Y., New York—A. Cicerone, c/o S. J. Kessler, Engr. and Archt., 549 Courtland Ave., will build a 3 story garage on East 77th St. Estimated cost $30,000.

N. Y., New York—The Studebaker Corp. of America, Main ond Bronson Sts., South Bend, Ind., awarded the contract for the construction of a 6 story, 175 x 200 ft. sales and service station on West 131st St., here. Estimated cost $400,000. Noted Jan. 18.

N. Y., Syracuse—The New Process Gear Corp., 500 Plum St., awarded the contract for the construction of a 1 story, 50 x 160 ft. heat treating plant. Estimated cost $19,000.

O., Barberton—The Ohio Insulator Co. awarded the contract for the construction of a 1 story, 50 x 480 ft. factory. Estimated cost $75,000.

O., Cincinnati—The Hanna Locomotive Stoker Co., 411 4th Natl. Bldg., awarded the contract for the construction of a 1 story, 90 x 140 ft. factory. Estimated cost $40,000.

O., Cleveland—The Ancaster Co., c/o J. V. D. Miller, 7500 Euclid Ave., awarded the contract for the construction of a 1 story, 148 x 250 ft. commercial building and garage at 7421 Carnegie Ave. Estimated cost $60,000.

O., Cleveland—The Cleveland Heater Co., 1905 West 112th St., awarded the contract for the construction of a 1 story, 30 x 240 ft. addition to its factory on Locust Ave. and 112th St. Estimated cost $100,000. L. Friedman, Pres. Noted Aug. 3, 1922.

O., Cleveland—The Ferro Machine & Fdry. Co., East 66th St. and Hubbard Ave., has had plans prepared for the construction of a 1 story, 70 x 100 ft. foundry. Estimated cost $40,000. Private plans.

O., Cleveland—The Lake Erie Metal Products Co., c/o J. F. Strnad, Pres., 4001 West 25th St., awarded the contract for the construction of a 1 story, 60 x 160 ft. factory on East 152nd St. Estimated cost $60,000. Noted Apr. 26.

O., Cleveland—M. N. Miller, 2036 East 105th St., has had plans prepared for the construction of a 1 story, 45 x 190 ft. garage at 2134 East 107th St. Estimated cost $40,000. Private plans.

O., Cleveland—The Pontiac Improvement Co., c/o A. L. Corlett, Pres., 3328 Vega Ave., awarded the contract for the construction of a 2 story, 101 x 120 ft. automobile sales station and garage on Ansel Rd. and Superior Ave. Estimated cost $150,000. L. L. Carlozzi Co., 1258 East 105th St., Cleveland, Ford dealers, lessee. Noted Apr. 26.

O., Cleveland—J. Rutkowski, 6600 Park Ave. (steel and iron), awarded the contract for the construction of a 1 story, 60 x 100 ft. forge shop. Estimated cost $40,000.

O., Middletown—The Washington Motor Co., Eaton, plans to build a plant for the manufacture of automobiles, here.

Okla., Okmulgee—The X. R. Gill Co., is having plans prepared for the construction of a 3 story, 78 x 118 ft. garage. Estimated cost $125,000. Smith & Smith, 401 Commerce Insurance Bldg., Okmulgee, Archts.

Pa., Greenville—The Bessemer & Lake Erie R.R., Union Arcade, Pittsburgh, will build a 1 story, 35 x 40 ft. machine shop and turntable, here. Estimated cost $60,000.

Pa., Mansfield—S. B. Bishop has purchased site and plans to build a machine shop, garage and service station on Normal Pl. and South Main St. Cost between $15,000 and $18,000.

Pa., Phila.—J. C. Kohn, Norris Bldg., awarded the contract for the construction of a 2 story, 40 x 160 ft. service building at 1427 North Broad St. Estimated cost $250,000.

Pa., Phila.—Krakstein & Markowitz, 1214 Filbert St., awarded the contract for the construction of a 4 story, 60 x 120 ft. garage. Estimated cost $100,000.

Pa., Phila.—A. Leibowitz, 4045 Baltimore Ave., is receiving bids for the construction of a 1 story, 63 x 100 ft. garage on 63rd and Woodbine Sts. Estimated cost $50,000. F. P. Canavan, 7030 Greenway Ave., Phila., Archt.

Tenn., Memphis — The Broens-Weller Truck Body Co., 345 Jefferson Ave., plans to build a 2 story addition to its plant, consisting of a machine shop and carpentry rooms, etc. Estimated cost $50,000.

W. Va., Charleston—The Kanawha Mfg. Co., manufacturer of boilers and mine equipment, awarded the contract for the construction of a 2 story, 36 x 70 ft. office building and a 66 x 160 ft. factory. Noted Jan. 25.

W. Va., Wheeling—The Hazel Atlas Glass Co. awarded the contract for the construction of a 2 story, 60 x 107 ft. machine shop. Estimated cost $40,000.

Wis., Delevan—W. M. McCommous will build a 2 story, 50 x 90 ft. garage. Estimated cost $40,000.

Wis., Kenosha—The Simmons Mfg. Co., 160 Exchange St., will build a 6 story, 100 x 282 ft. factory for the manufacture of steel furniture. Estimated cost $350,000.

Wis., Sheboygan—The F. Hensel Co., Center and North 7th Sts., awarded the contract for the construction of a 3 story, 60 x 100 ft. garage and repair shop. Estimated cost $40,000. Noted Apr. 12.

Wis., Sheboygan—J. Van der Vaart, 536 Pennsylvania Ave., is having plans prepared for the construction of a 4 story, 60 x 120 ft. garage and repair shop. Estimated cost $70,000. E. A. Juul, Security Bldg., Sheboygan, Archt. Noted Apr. 12

Ont., Acton—The Thomson Motor Supplies, Ltd., 415 Queen St., W., Toronto, are having plans prepared for the construction of a 2 story factory for the manufacture of automobile accessories, here. Estimated cost $25,000. Smith & Wright, 2945 Dundas St., W., Toronto, Archts. Noted Nov. 23.

Ont., Hamilton—The Stanley Steel Wks. of Canada, Ltd., Arthur St., plans to build additions to its plant. Estimated cost $100,000. A Hatch, Mgr.

Ont., London—The Starr Phonograph Co., 265 Dundas St., plans to build a plant. Estimated cost $50,000. J. A. Croden, Mgr.

Ont., Windsor—The Universal Garage, Chatham St., awarded the contract for the construction of a 2 story addition to its garage. Estimated cost $30,000.

ADDITIONAL OPPORTUNITIES

Equipment
Business

Employment
Miscellaneous

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SEARCHLIGHT SECTION

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